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HOUSE COMMITTEE PRINT

STUDY OF NEWSPRINT EXPANSION

A PROGRESS REPORT

OF THE

DEPARTMENT OF COMMERCE

TO

SUBCOMMITTEE NO. 5 OF THE
COMMITTEE ON THE JUDICIARY
HOUSE OF REPRESENTATIVES

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PREFACE

THE SECRETARY OF COMMERCE,
Washington, D. C., October 1, 1952.

The Honorable EMANUEL CELLER,
Chairman, Committee on the Judiciary,
House of Representatives, Washington, D. C.

MY DEAR MR. CHAIRMAN: You will be thrilled as I am by the progress report being made to you by the Department of Commerce as a result of your committee's request on May 27, 1952, that the Department of Commerce undertake to explore the factors impeding the expansion of newsprint production in the United States and the investigation of the possibilities of utilizing new raw materials and technologies in the manufacture of newsprint.

First, may I congratulate you upon taking the initiative in this important matter and then point with pride to the things which have been accomplished by my Department.

It has been clearly demonstrated that we can manufacture from whole bagasse (sugarcane wastes) a paper satisfactory in all important respects and superior in some to newsprint now currently in use. It is also indicated that the total costs of manufacturing newsprint from bagasse are at least as low—and in my opinion probably will eventually be much lower—than production costs of newsprint now used. It is also clear that bagasse could be used economically as a blend with other pulp in the manufacture of standard newsprint and, because of its superior strength and other characteristics, may be suitable for the production of higher grade paper.

The trial tests in this research were conducted by the National Bureau of Standards of the Department of Commerce. The resultant products were subjected to every known test for comparison with standard newsprint. The tests of the National Bureau of Standards were supplemented by other work. The Government Printing Office made thorough printing tests and ran 100 copies of a sample issue of the Congressional Record on the new paper. A special panel of newsprint executives of leading newspapers gave personal judgments upon the acceptability of the samples. There seems to be no question of the superiority of the new paper.

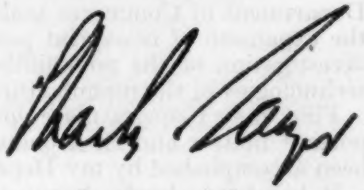
I do not wish to indicate that the Department of Commerce alone is entitled to credit. Assistance and advice came also from the Department of Agriculture, the Mutual Security Agency, and the Government Printing Office; and officials from the pulp and paper industry serving with the Department's National Production Authority have given us the benefit of their experience.

It is interesting to note that our program of research is not concluded. A Commerce-sponsored mission in Europe has been investigating the use of hardwoods as newsprint raw material and the Department of Commerce is studying developments in the use of deinked waste paper and other fibrous materials. That will be discussed in forthcoming reports.

You are well aware and many members of the public are also well aware of the problems faced by American newspapers in connection with newsprint. A goal of 494,000 tons of additional capacity was set on January 1, 1951. Capacity expansion to date has fallen about one-fourth short of that objective.

We are also faced with continuing shortages of suitable timber. The supply of bagasse is ample to take care of all our increased newsprint needs. Louisiana and Florida are substantial sugarcane producers. Great quantities are available in Hawaii and Puerto Rico and even greater quantities in Cuba and the rest of the Caribbean area. World production of bagasse is about 25 million tons a year, of which the United States and its Territories and Central America account for one-half. If only part of this supply is available for newsprint, potentialities are impressive.

Yours sincerely,



Secretary of Commerce.

LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF COMMERCE

CHARLES SAWYER, *Secretary*

OCTOBER 2, 1952.

Hon. EMANUEL CELLER,
Chairman, Committee on the Judiciary,
House of Representatives, Washington, D. C.

MY DEAR MR. CELLER: On May 27, 1952, the Antitrust Subcommittee of the Committee on the Judiciary requested that the Department of Commerce undertake a five-point program which would determine ways and means of developing additional domestic production of newsprint. This program contemplated discussions with present and potential producers of newsprint as well as with consumers of newsprint, the study of new processes and techniques for newsprint manufacture, and the coordination of Government activities directed toward expansion of newsprint in the United States.

Pursuant to the direction of the subcommittee, I herewith take pleasure in transmitting to you the first progress report of the Department of Commerce describing the measures which have been taken to comply with the subcommittee's afore-mentioned request.

In presenting this report to the subcommittee, the Department of Commerce wishes to acknowledge its deep appreciation for the effective aid and cooperation received from various other Government agencies, particularly the Department of Agriculture, the Mutual Security Administration, and the Government Printing Office.

Grateful acknowledgment is also made to the American Sugar Cane League, the Sugar Cane Institute, the Hawaiian Sugar Planters Association, the Association of Sugar Producers of Puerto Rico, and the United States Cuban Sugar Council for conducting special studies requested by the Department or furnishing other specific information as required. The technologists and inventors holding proprietary processes for making newsprint from bagasse, who participated in the trials at the National Bureau of Standards under conditions specified by the Department of Commerce, deserve warm praise for their willingness to submit their processes to objective test and appraisal. The Paper Section of the Department's National Bureau of Standards which conducted these tests rendered a valuable and capable service in the best traditions of that fine organization. The Herty Laboratory, Savannah, Ga., provided willing assistance on a number of occasions.

Special thanks are due to the newsprint producers and newspaper publishers who came to Washington to participate in special industry conferences called to discuss matters presented in this report. Particular appreciation is expressed to the newsprint executives of newspaper publishing organizations who participated in a unique panel

sponsored by the Department of Commerce in order to obtain their unbiased judgment as to the acceptability of bagasse newsprint for newspaper use.

The following Government officials gave freely of their time and counsel in serving on an interagency advisory group to the Department of Commerce as need arose: Carl Speh and Walter Scott of the Bureau of Agricultural and Industrial Chemistry; G. A. Trayer, H. R. Josephson, and R. M. Wirka of the Forest Service; J. E. Atchison and P. A. Forni of the Mutual Security Administration; R. B. Hobbs of the National Bureau of Standards; J. Kanegis, Office of Technical Services.

In the Department of Commerce, this program has been under the direction of Mr. Jesse J. Friedman, assisted by Dr. John R. Skeen.

Sincerely yours,

H. B. McCoy,
Director, Office of Industry and Commerce.

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STUDY OF NEWSPRINT EXPANSION

I. Introduction and Summary

At an executive session of the Antitrust Subcommittee of the House Judiciary Committee, held on May 27, 1952, the Department of Commerce agreed to undertake a five-point program calling for exploration of the factors impeding the expansion of newsprint production in the United States, and investigation of the potentialities of utilizing new raw materials and technologies in the manufacture of newsprint.

The full program as set forth in the report of this subcommittee, entitled "Newsprint Price Rise," House Report 505, part 3, is as follows:

1. That since the present expansion goal has not been met to date the Department of Commerce will, on behalf of the Government, explore the obstacles which have thus far militated against additional newsprint expansion in the United States.

2. The Department will consult with present producers in the field as well as with potential producers, including producers seeking to enter newsprint production via new techniques and processes such as bagasse, hardwoods, etc., with a view to obtaining new newsprint facilities which will fulfill our expansion goals.

3. In order to obtain accurate scientific and technological data upon which to appraise the value of new techniques and processes, the Department will obtain the cooperation of the Bureau of Standards and other appropriate laboratories to make definitive tests which may then provide a sound basis for future policy decisions regarding these technical innovations.

4. The Department of Commerce will, at the same time, discuss with publishers and representatives of publishers' groups to obtain and coordinate whatever aid and assistance the latter are able to proffer in expanding domestic newsprint production.

5. The Department of Commerce will likewise confer and coordinate its efforts with the activities of other Government agencies which may be concerned with the various aspects of obtaining new production such as financing, priorities, amortization, etc.

The purpose of the present report is to inform the subcommittee as to the progress of the work undertaken pursuant to the above program, to summarize the significance of the results to date, and to indicate the lines along which further inquiry appears to be needed.

SUMMARY OF ACTIVITIES

During this initial period our activity has been divided into three main parts:

A. Consulting with private industry and Government agencies to determine the extent of expansion of newsprint production already planned or underway in the United States, and obtaining the viewpoints of private industry and Government agencies as to the obstacles impeding further expansion at this time.

B. Surveying the status of research, development, and technology in the United States and abroad as to the utilization of raw materials (including sugarcane bagasse, hardwoods, and waste paper) not now used to a significant extent in the manufacture of newsprint.

C. Conducting an independent investigation as to the feasibility of making satisfactory newsprint from sugarcane bagasse on a pilot scale by already existing processes, and studying the economic considerations affecting the use of bagasse as a raw material for newsprint production.

The following specific activities are indicative of our general approach in carrying out the initial phase of the program.

1. Formed an interagency advisory group under the sponsorship of the Department of Commerce to coordinate views and studies of the executive branch in connection with expansion of newsprint production.

2. Convened, under the auspices of the National Production Authority, two industry meetings: (*a*) An industry advisory conference of all existing newsprint producers in the United States, plus three prospective producers; and (*b*) A special meeting of the Newspaper Industry Advisory Committee consisting of representative newspaper publishers in the United States.

The purpose of both of these meetings was to obtain the views and judgments of private industry with respect to factors affecting expansion of newsprint production.

3. Conducted trials at the pilot paper mill of the National Bureau of Standards of the Department of Commerce, involving (*a*) the manufacture of newsprint from bagasse on a pilot scale by various processes, and (*b*) exhaustive physical testing of such newsprint in comparison with standard newsprint.

4. Arranged for and completed the performance of tests by the United States Government Printing Office, for evaluating the printability of newsprint papers manufactured from bagasse in comparison with the printing quality of standard newsprint. Also arranged for printing a sample issue of The Congressional Record on newsprint made from bagasse.

5. Convened a special panel of newsprint executives of leading newspapers to judge and evaluate the acceptability of newsprint samples made from bagasse in comparison with various samples of standard newsprint.

6. Arranged for and obtained special area studies as to supply availabilities and price considerations for bagasse originating in the United States, Hawaii, and Cuba.

7. Arranged for and obtained special economic and technical studies by the Forest Service concerning (*a*) availability of timber supplies

for expanded production of newsprint, and (*b*) possibilities of utilizing hardwoods and waste paper in the manufacture of newsprint.

8. Organized and dispatched a special Mutual Security Agency-Department of Commerce mission to study at first hand European developments in utilizing hardwoods in the manufacture of newsprint, with particular emphasis upon the technology and economics of the newsprint industry in Italy, where most of the timber going into newsprint consists of hardwoods.

9. Conferred with prospective producers actively interested in using hardwoods and waste paper for newsprint manufacture in the United States.

10. Compiled and reviewed data concerning availability of timber in Alaska for newsprint production and studied economic conditions and Government policies affecting feasibility of such production.

SUMMARY OF RESULTS

The principal findings and conclusions suggested by our efforts to date may be summarized as follows:

The views of private industry

1. Expansions of capacity undertaken by the domestic newsprint industry since mid-1950 totaled 375,000 tons and involved a total investment of about $110 million. All expansion projects have been granted accelerated amortization at the rate of about 45 percent. The expansion undertaken to date falls about one-fourth short of the defense expansion goal established by the Government. No further expansion projects to fill this goal have been submitted by newsprint producers.

2. The reluctance of newsprint producers to undertake further expansion at this time is attributable to (*a*) inadequacy of available supplies of softwood timber (the principal raw material now used for newsprint) to permit substantial expansion of newsprint production in the United States, and conservatism as to the feasibility of utilizing alternative raw materials; (*b*) high investment costs for the acquisition of necessary timberlands and construction of new mills and the competitive disadvantage of new ventures in comparison with existing facilities built at lower costs; (*c*) higher profitability of other grades of paper in relation to newsprint resulting in a diversion of available capital and raw materials away from newsprint to such other grades.

3. Some newsprint producers are of the opinion that available supplies of softwoods could be substantially increased and newsprint production thereby expanded by modifying Government policies which now prohibit the cutting of timber in the Olympic National Forest in the State of Washington and the importation of logs cut from the Tongass National Forest in Alaska. (Present regulations require that the first processing of logs cut from the Tongass Forest must be performed in Alaska.) The Newspaper Industry Advisory Committee of the National Production Authority has recommended that a study be made of the possibility of utilizing such sources of timber for the production of forest products, including newsprint, under proper restrictive safeguards which would assure the perpetuation of the natural resources.

4. Newspaper publishers have investment participation in a number of existing newsprint mills in the United States, including the two

large newsprint mills in the South. The Newspaper Industry Advisory Committee of the National Production Authority, which is made up of representative large and small newspapers from all sections of the United States, is of the opinion that newspaper publishers would provide reasonable amounts of equity capital to start new mills. While capital investments in other paper products are said to provide a better financial return than newsprint, the committee generally believes that publishers would invest in newsprint mills if the raw material for newsprint production were available.

5. The Newspaper Industry Advisory Committee is of the view that all of the output of the expanded capacity which is underway will be absorbed in the market regardless of newsprint conservation programs, rising prices, or any other considerations. Committee members urge that the expansion goal be enlarged when and if specific applications are filed in excess of the present goal, and that no person who wishes to enter the newsprint production field be deterred from doing so because of the fact that the planned goal has been reached.

6. While the newsprint industry generally opposes Government financial assistance in the form of subsidies, several producers are of the opinion that the privilege of applying for Reconstruction Finance Corporation loans or rapid tax amortization certification should continue to be available to those companies which wish to exercise it.

Utilization of bagasse for newsprint production

1. On a pilot scale, using equipment which is standard to the art, it is technologically feasible to manufacture from whole bagasse a paper which is satisfactory in all significant respects, and superior in some, for use as newsprint.

2. On a pilot scale, total costs of manufacturing newsprint from whole bagasse, including raw material costs, are in line with production costs for standard newsprint.

3. Of the various newsprints manufactured from bagasse on a pilot scale by the National Bureau of Standards during these trials, the best results were obtained by using the De La Roza process. Other processes also show potentialities for successful development.

4. Bagasse could also be used economically as a source of chemical pulp, or as a blend with other pulps, in the manufacture of high-quality newsprint.

5. Because of the superior strength and other characteristics of the fiber compared to ground-wood fiber, bagasse is also suitable for the production of other types of paper, particularly higher grade papers, perhaps most economically in combination with the manufacture of newsprint.

6. The above conclusions are necessarily based upon experience on a pilot scale. Certain technical details which cannot be adequately determined on such a scale must be subjected to commercial conditions before it can be determined with finality that these conclusions apply equally to commercial scale operation. Two matters requiring conclusive demonstration in order to eliminate any uncertainty as to economic practicability are (1) the maximum speed at which newsprint from bagasse can be made on a standard paper machine, and (2) the maximum speed at which such newsprint can be printed on a typical newspaper press.

7. It is technically and economically feasible to store bagasse for indefinite periods of time. The sugarcane grinding season is about 2½ months in Louisiana and about 6 months in Florida and Puerto Rico. Year-round availability in these areas presents no difficulty; when properly baled, treated, and stacked, bagasse can be kept for several years without significant loss. In Hawaii the cane-grinding season extends throughout most of the year, thus requiring little or no storage for the bagasse produced.

8. Almost 1 ton of newsprint can be made from 2 tons of bagasse. While the United States is not a major sugarcane producer, ample quantities of bagasse are annually available in Louisiana and Florida to support at least two newsprint mills of economic size utilizing bagasse as a raw material. Even greater quantities of bagasse are available in Hawaii and Puerto Rico, which together produce about three to four times as much sugarcane as the United States. Still greater supplies are available in Cuba, which alone produces two to three times as much as the United States and its Territories combined. On a world-wide basis about 25 million tons of bagasse are produced annually, with the United States and its Territories and Central America accounting for roughly one-half of the world total. Utilization of this tremendous potential supply depends upon economic conditions in each locality.

SUMMARY OF FURTHER INVESTIGATIONS REQUIRED

In order to further the program undertaken by the Department of Commerce pursuant to the inquiry of this subcommittee, the following additional investigations are necessary:

1. Bagasse

(*a*) The feasibility of forming bagasse newsprint on a standard paper machine at commercial speeds and of printing such newsprint on a standard newspaper press at economic press speeds should be determined by actual test runs on such equipment.

(*b*) The economic factors affecting availability of bagasse in the United States and its Territories for newsprint production should be more thoroughly studied to determine possible economies in raw material costs, including treatment, storage, baling, and transportation costs.

(*c*) Further study is also required, both from the standpoint of potential newsprint expansion and the economics of the areas affected, in order to determine the economic practicability of drawing upon bagasse supplies in Cuba and other nearby sugar-producing areas, and the full significance of bagasse availability in major sugar-producing countries of South America and the Far East for paper manufacture, including newsprint.

2. Hardwoods

Technological developments concerning the utilization of hardwoods in the manufacture of newsprint offer considerable promise. Commercial application of these developments is not as far advanced in the United States as it is in some other countries. The technical and economic feasibility of extending hardwood utilization on a large scale as a means of expansion of newsprint production in the United States should be thoroughly investigated.

3. Waste paper and other materials

Considerable developmental work in the use of de-inked waste newspapers and other fibrous materials in the manufacture of newsprint is in progress. The technical and economic feasibility of substantially enlarging raw-material supplies for newsprint production by this approach should be ascertained.

4. Alaska

The possibility of utilizing the vast timber supplies available in Alaska for expansion of newsprint production, without impairing either prudent resource policy or the sound economic development of the Territory, should be determined.

5. Olympic National Park

The factors impeding access to the timberlands in the Olympic National Park should be carefully explored to determine the possibility of developing a program of sound logging operations which would not endanger national park policy and recreation objectives.

II. Requirements for Expansion of Newsprint Production [1]

A definite ratio exists between United States total consumption of newsprint and the Federal Reserve Board Index of Industrial Production. This correlation points to a constant growth trend. Although the relationship of newsprint consumption to the FRB index is not as good a fit as that between production of paper and board to the same indicator, the relationship is still sufficiently close to estimate forward consumption requirements. The following chart discloses the correlation between total United States newsprint consumption and the level of the Federal Reserve Board index of industrial production.

The primary assumption is that the consumption of newsprint when expressed in terms of tonnage will follow the FRB index relatively closely from year to year. Studies made of this relationship indicate a fairly close correlation when no special restrictions as, for example, limitations or other controls, are placed upon it. A further observation indicates that the average annual consumption of newsprint since 1929 represents a better correlation with the FRB index than any other period of years. Furthermore, given a projection of the FRB index in the future, requirements for newsprint will conform relatively closely to the ratio that has existed in the past 20 years.

By using the projected levels of the FRB index of industrial production for the years 1952–55 it is indicated that total United States requirements for consumption of newsprint in 1955 would be 6,900,000 tons.

The correlation of newsprint domestic production to the FRB index shows a negative relationship as stated above. A brief explanation of this phenomenon points to the fact that other factors affecting newsprint production in the United States have come into play. For example, the industry was identified by a strong growth trend from 1899 to 1926 and deviations away from this trend were short-lived. From 1926 to 1944 the industry has experienced an almost constant downward trend. This, of course, is attributable to certain factors of which two are the most important. In 1911 the tariff on newsprint

[1] This chapter consists of the study prepared by the Pulp, Paper, and Paperboard Division of the National Production Authority in support of its recommended newsprint expansion goal of 494,000 tons.

imports from Canada was removed and Canadian newsprint was placed on the American free list. This put low-cost Canadian production in direct competition with American newsprint. In the course of the years from 1910 through 1926, although domestic production was increasing, it was not increasing relative to the flow of American buyers to the Canadian production area. The full effect of the shift of the industry to Canada came into play from 1926 on. In the past few years there have been indications that the downward trend in domestic production of newsprint has been leveling off and that the bottom of the cycle was probably reached in 1944. In fact, since the end of World War II domestic newsprint production has been in an almost constant gradual upswing.

Another analysis of newsprint requirements for consumption was made purely on the basis of correlation with per capita consumption of newsprint related to population growth. This analysis discloses that there is a positive relationship between both total newsprint consumption requirements and the per capita newsprint consumption and the FRB index.

Forward estimates of consumption can be measured on this basis. For example, the long-term relationship between per capita domestic consumption of newsprint and per capita FRB index, discloses additional newsprint capacity within the United States would be feasible.

Based on the long-term relationship of either total consumption or per capita consumption of newsprint to the FRB index, requirements by 1955 are estimated to increase by about 800,000 tons. Naturally, this increase in consumption requirements must be made up either in the United States or in Canada. Present indications point to the fact that, except for the recently completed Crown-Zellerbach mill at Vancouver, Canada is not building new newsprint production facilities. She has been engaged in speeding up existing newsprint-production facilities, but the speed-up program in Canada appears to be leveling off. Therefore, much of the increased United States consumption requirement appears necessary to be produced within the United States.

There are both negative and positive factors which may be considered with respect to the long-range future trend of total United States newsprint consumption. Some of these same negative or positive factors would apply to the short-term 5-year period being considered in this report. It is probably impossible to consider and analyze each and every minus and plus factor but an attempt is being made to refer to at least some of the more important considerations.

On the negative side of a continued expansion in the consumption of newsprint paper in the United States would be the possible effect of the expected Nation-wide television hook-up within the next couple of years. There are some observers who feel that when the United States is blanketed with television there will be a distinct decline in reading interest, not alone for newspapers but as well for books, magazines, and other periodicals. There are, however, other observers who point to the experience in the few eastern cities where television has been

available for 2 or 3 years that once the novelty wears off the average person tends to view only a few selected programs and, therefore, reverts back to his normal practice of devoting more time to reading.

There are also other observers who feel that the majority of the population have reached an educational standard whereby they feel that it is a fundamental duty to read the daily newspapers in order to be properly informed of domestic and international economic and political developments. However, even in such instances there has been some indication that families which had been purchasing three or four newspapers a day have seen fit to get along with perhaps one or two papers, partly accounted for by television and partly because of the increased cost of living dictating economizing on the family budget.

Indications are that the rapid acceleration of newsprint consumption within the United States is facing a slow down. This is not to say there will not be a constant growth in newsprint consumption within the United States in the next 5 years but that increases will be much less steep than previously. Probably a major factor in this apparent leveling off of newsprint consumption is the cost problem throughout the production and the publishing end of the industry. Newsprint prices have doubled since 1941, but this increase in price is in direct proportion to the wage increases over the same period. This means that the whole industry reflects higher basic cost, higher circulation and advertising rates. The cost of raw newsprint to the newspaper publisher today represents 50 percent more of his total operating cost and there is no likelihood that newsprint prices are going to level off within the next 5 years. The advertiser who pays $10,000 for a full-page ad will be faced eventually with getting much less than a page for this price. This can only mean a loss of some advertisers. On the other hand, the cost to the purchaser in circulation rates are likely to continue rising over the same period. Both these factors point to at least a marginal decline in newsprint consumption in total and per capita. This, of course, is only relative because the total trend will still be up but it points to the fact that a per capita consumption of 80 pounds per person in the United States in 1951 perhaps indicates a peak rather than a jumping-off point for future increases. It seems more likely that the next 5 years will see a per capita decline in newsprint consumption—not an alarming one but at least a moderate one.

On the positive side there is primarily the factor that the population of the United States is nearly 100 percent literate. Furthermore, with the large segment of the population having been active in World War I and II, as well as in the present Korean conflict, there has developed a broad-scale interest in the activities of the United States as well as domestic and international affairs, generally, and there is a strong desire to maintain day-to-day knowledge of such developments. The newspapers, of course, offer suitable complete coverage of current news along with numerous editorials on the subjects. Whereas it is recognized that both radio and television give current news coverage, the newspapers are still considered by most people to be the fundamental source of the information they desire.

The Printing and Publishing Division of NPA points out that in any projection of the usage of newsprint over the next decade of years, allowance should be made for increased consumption by weekly, semi-

weekly, and community newspapers, other than dailies. This group of papers consume 3½ percent of our present consumption and this could very easily be doubled within the next 10 years. The 1950 usage of newsprint by this group of papers was approximately 210,000 short tons which means that during the next 10 years an increased consumption of from 150,000 to 300,000 tons might be anticipated.

The thought is growing among newspaper communities in the country that the coming years will see a large development in strong weeklies. There are many reasons for this. The financing of a new daily in most towns runs into a lot of money. The equipment alone is very expensive. With a weekly the total expenses of starting a new plant is much reduced and the cost of distribution is reduced; in other words, the plant investment is smaller, the operating cost is lower, and the field attractive. Because of the lesser finances involved the opportunity for development is greater.

Bureau of the Census data indicates there are 9,800 weeklies in the country and 2,200 other publications of lesser frequency, totaling 12,000. These figures are larger than those submitted by various regional press associations but the importance of the number is not too great because many of them use a very small amount of newsprint, but as stated above, the group as a whole uses about 3½ percent of total United States newsprint consumption.

Both the negative and positive observations are of a nebulous character since there is no definite means of determining the reaction of the population in the years ahead and certainly there is no statistical basis for measuring such factors.

It is, therefore, appropriate that the projected trend of total United States newsprint consumption as based upon the history of the past 30 years be logically assumed to continue over the period 1952–55. The question, however, arises as to the source of total United States newsprint requirements during this period. At this point, it is necessary to analyze the world situation with regard to newsprint supply and requirements and to determine the most likely developments in this field. The International Materials Conference established a Pulp and Paper Committee in April 1951. The Pulp and Paper Committee assembled statistical data on newsprint supply and requirements from all countries except those in Eastern Europe.

Following careful appraisal of the available data by the committee, it was determined that in 1951 there was an apparent world deficit outside of North America of approximately 400,000 short tons. These requirements did not allow for any major increase in consumption of newsprint in some countries where at present only 4-page newspapers are printed but where eventually there would be a need for much larger newspapers, perhaps up to 30 or 40 pages a day.

Upon a careful screening of the indicated world deficit of newsprint outside of North America, an observation was made that the bare essential requirements, allowing for only very nominal increases in consumption in some countries, would amount to close to 200,000 short tons above available supply in 1951.

Although the committee did not attempt to screen the data for 1952 indicated world requirements of newsprint, the deficit also appeared to be in the neighborhood of 400,000 short tons.

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It should be observed that in the above Pulp and Paper Committee statistical analyses no allowances were made for increased requirements in the United States or Canada although it is generally known that at least during 1951 a moderate shortage existed in the United States especially in the first 6 months. Although no actual statistical appraisal has been made, it may be estimated that a shortage existed of perhaps 2 or 4 percent above available supply, or somewhere in the neighborhood of 100,000 to 200,000 short tons. As a consequence a somewhat arbirtrary figure as to total world deficit in 1951 or 1952 could be stated as being approximately 600,000 short tons.

A large part of the world shortage of newsprint is centered in the West European area where there is no likelihood of any substantial increase in newsprint production because of lack of forest resources. Even in the Scandinavian countries it is generally noted that the forests have been overcut in recent years and that the aggregate production of pulp and paper will not be increased. Furthermore, because of economic considerations, the Scandinavian countries have already seen fit to increase the production of higher priced items such as dissolving wood pulp and higher grade types of paper to the detriment of much, if any, further increased output in the lower-profit-margin newsprint.

The coniferous forests of the world are located predominately in the Northern Hemisphere encompassing North America, Europe, Russia, and Communist satellite countries. Up to the present time, newsprint production has been economically possible only from coniferous trees even though recent technoligical developments suggest that over a long period of time it may be possible to utilize the large hardwood timber resources of Africa, South America, and other parts of the world, in the production of newsprint. The problem with hardwood utilization is that in most every hardwood forest several species of trees are found and, therefore, logging and manufacturing costs become prohibitive if it is necessary to only utilize one or two particular species for satisfactory pulp and paper production. Even though newsprint production in the Southern Hemisphere may eventually be possible through the utilization of hardwoods or such other raw materials as bagasse, there is the time element and market factor to be considered.

The newsprint requirements of numerous countries would not absorb the output of a local modern mill and, therefore, foreign markets would be necessary. To be successful, a modern newsprint mill must be sufficiently large in capacity to justify the high costs of plant and equipment which runs from $25 to $50 million for a new mill of 100,000 tons annual production. To organize financing, develop logging and other transportation facilities, design and erect a mill would probably take a good many years in various foreign countries. An instance in point is the Klabin mill in the State of Parana, Brazil, which took approximately a decade from the time it was first started until it was put into moderately successful operation utilizing Parana pine. And even now it is reported that because of very costly logging conditions as well as transportation problems that without Brazilian Government financial backing (which was evident from the very start) that the mill would not be able to compete pricewise with North American newsprint. It, therefore, could be generally concluded that no major

expansion in the Southern Hemisphere could be expected during the present decade.

These observations lead to a conclusion that any immediate new production of newsprint either from domestic or world consumption would most likely depend upon new facilities being constructed in North America where there is still substantial coniferous forest resources in Alaska, in many parts of Canada, and in a number of areas of the United States including the southern region of the United States. No definite information is available as to plans for expansion in the Canadian newsprint industry. However, it is known that the new Crown-Zellerbach mill at Duncan Bay on Vancouver Island, British Columbia, is the only new newsprint mill constructed in Canada during the past 10 years. Increased Canadian production amounting to close to 200,000 tons a year in the period 1946–51 has been possible through modernization and speeding up of present newsprint-mill facilities. It is believed, however, that there is a limit to which additional production can be obtained through this process without outright installation of new pulp digesters, new mechanical wood-pulp grinders, and new newsprint machines. Whether or not further new capacity in Canada is developed is indeed a questionable factor since the trend of the past 10–15 years has been definitely toward new capacity for the production of higher grade and higher priced items such as market wood pulp (including dissolving pulp) and grades of paper and paperboard other than newsprint. It will be noted that this is the same general situation which has prevailed in the Scandinavian countries and, for that matter, in the United States itself.

There is no assurance that any major further increase in newsprint capacity can be counted upon in Canada beyond possible moderate increase through modernization and speeding up of present machines which in the aggregate might be estimated in the neighborhood of an increase of up to 150,000 tons per year plus about 70,000 tons a year from the new Duncan Bay mill in British Columbia which is expected to start operating by July 1952.

Therefore, it appears necessary to expand production facilities in the United States itself to meet a substantial part of increased domestic newsprint requirements. This observation may be further substantiated by the fact that the United States was fortunate during the past 3 or 4 years in obtaining larger supplies of newsprint from Canada than would have been possible were it not for the serious shortage of dollars which developed in many countries of the world such as in the United Kingdom, most of the Latin-American countries, as well as New Zealand, Australia, and parts of the Far East. As a consequence, Canada lost a part of those long-established Canadian markets for newsprint and it is only apparent currently that some of these markets have regained sufficient dollars whereby again to seek Canadian newsprint.

From a long-range point of view it could be reasonably assumed that Canada would be interested in maintaining many such logical foreign markets in addition to the United States and, therefore, an observation may well be made that during the next few years a larger portion of Canadian newsprint may be diverted to such other foreign markets. Still another factor to be considered is the fact that the population of Canada is rapidly increasing together with greater

literacy and that newsprint consumption in Canada itself has been for some time on an upward trend.

Upon considering all the factors analyzed above it may be reasonably concluded, taking into account possible moderate increases in Canadian production, that such increases for the most part would be diverted to other foreign countries and that the United States may not expect any substantial increase in supplies of newsprint paper from Canada between now and 1955. Most of the new Duncan Bay mill output will likely be available to United States buyers. Estimated total newsprint imports from Canada and overseas are shown in a following table.

If we, therefore, accept the projected requirements figure for 1955 amounting to 800,000 short tons increase over 1951 we come to the conclusion that for the most part this quantity would have to be produced in the United States. For that matter, considering the world deficit discussed above, we might assume that the United States (similar to Canada) would also have a world market available for a substantial quantity of newsprint paper but it is doubtful that the United States export level will increase much above 1950.

As further substantiating evidence for the need for additional newsprint production in the United States (or Alaska) some of the more important fundamental commercial and economical considerations should be taken into account.

Newsprint production in the United States continued generally upward until the year 1926. From that time until a few years ago production of newsprint in the United States was downward. At the same time, however, newsprint consumption in the United States was on a general upward trend and this increased consumption was made possible largely from a proportionately growing capacity and production in Canada. Notwithstanding the fact that the 1920–29 decade was a prosperous period and witnessed major expansions in the United States pulp industry, particularly in the field of kraft wood pulp and in container and boxboards, it was a period of strong industrial competition. The United States newspaper-publishing industry was anxious to maintain a continuing supply of low-cost newsprint and was successful, as stated previously, in having newsprint made free of import duty in 1911. However, this did not influence a major shift in production of newsprint to Canada until the 1920–29 decade when the United States mills found it more profitable to switch to other grades of paper. At the same time Canadian enterprise, fostered by United States publishers, saw fit to take advantage of the large forest resources of Canada consisting largely of spruce and balsam fir ideally suited for newsprint, coupled with lower labor costs and cheap hydroelectric power facilities.

As a consequence and because of cost and other economic considerations, newsprint production in Canada continued to rise to the present time, whereas United States production witnessed a generally downward trend until within the last few years.

It is obvious that economic and industrial conditions at the present time may be substantially different from the previous 30 years with respect to newsprint. For example, pulpwood timber in Canada is becoming more remote and more expensive to get to the mills, labor costs have rapidly advanced and are closely approaching similar labor costs of the United States, and both water and railroad transportation

costs have likewise increased materially. As a consequence the cost of delivering a ton of newsprint from Canada into many United States markets is such that it now appears economically sound for a further increase in productive capacity in the United States.

In considering newsprint production, both in Canada and in the United States, it is probably necessary to consider production east of the Rocky Mountains and that west of the Rocky Mountains.

Because of freight-rate considerations and other factors it could well be observed that British Columbia, Washington, and Oregon would be the logical source of supply to meet west-coast demands and for export to such countries as the west coast of South America, Australia, New Zealand, and certain areas of the Far East. On the other hand, it is doubtful if west-coast production could economically compete in the eastern United States area except by water movement to major port centers such as Houston, New Orleans, or Jacksonville. However, with regard to eastern production it is conceivable that eastern Canadian newsprint could continue to compete by water transportation in the same major port areas.

It would also seem to be a fair observation that because of lack of extensive forest resources in the New England, New York, and Lake States of the United States, Canadian newsprint would continue to largely dominate the major markets in these regions. Our attention is, therefore, drawn primarily to the newsprint-consumption requirements of the inland areas of the deep South and the Prairie States. This area could roughly be defined as the newsprint price selling zones 5, 6, 7, 8, and 9, excepting North and South Dakota, as established by the newsprint industry for pricing purposes with the exception as noted above of the principal cities and nearby areas having ocean-port facilities.

The foregoing observations are substantiated by actual recent developments, namely the construction of the Lufkin, Tex., newsprint mill which started production in 1940 and has more recently expanded facilities, as well as the newsprint mill at Coosa Pines, Ala., which started production in 1950. It should be borne in mind, however, that in both of these projects the newspaper publishers in the southern or midwestern areas assisted in financing the mills and guaranteed long-term contracts for the production of the mills.

In view of the above observations, it is important to analyze the apparent consumption trends of newsprint in the south and central areas described above to determine an approximation of requirements compared to current southern production facilities. A statistical appraisal discloses that by 1955 the inland, southern, and central areas could consume a total of 1,200,000 tons of newsprint whereas current capacity of the Lufkin, Tex., and Coosa Pines, Ala., mills aggregate only about 250,000 tons, an apparent net regional requirement by 1955 of 1,040,000 tons.

There would also remain a general observation which could be best met by the United States Forest Service with regard to timber resources capable of supporting increased newsprint production in the South and more particularly from a competitive point of view when newsprint mills will have to compete pricewise for pulpwood available on the open market in the southern region. In other words, unless a new newsprint mill in the South were able to acquire timberland holdings sufficient to meet most of its pulpwood requirements, it would

seem inevitable that sooner or later such mills would have to bid for stumpage against other mills producing higher priced products.

Additional newsprint production in the United States (or Alaska) may be able to compete particularly on the Pacific coast or to some degree in the Lake or Northeastern States.

SUMMARY

In view of the above analysis of the newsprint situation in the United States, Canada, and in the entire world, it appears economically sound to establish a newsprint requirement for expanded domestic production. The estimated requirement from domestic production of newsprint, which is estimated to be in the neighborhood of 1,440,000 tons in 1952, will probably increase to 1,590,000 tons in 1953; to 1,665,000 tons in 1954; and to 1,660,000 tons in 1955.

In view of numerous indefinite factors analyzed in this report as to commercial and economic developments in the world newsprint situation during the next several years, it is recommended that this report be reviewed and revised periodically. For the purpose of strictly current programs, it is recommended that the estimated newsprint requirements from domestic production for 1953 amounting to 1,590,000 tons be used. The practical United States newsprint capacity as of January 1, 1951, was 1,096,000 tons. Therefore, an apparent deficit in domestic newsprint capacity of 494,000 tons is indicated.

TABLE 1.—*United States newsprint apparent consumption, production, imports, exports, and requirements, 1929–51*

[Thousands of short tons]

Year	FRB index of industrial production (1935–39=100)	Apparent consumption	Production	Imports	Exports	Total domestic production plus exports	United States newsprint capacity
1929	110	3,813	1,409	2,423	19	3,832	1,695
1930	91	3,496	1,226	2,280	10	3,506	1,712
1931	75	3,261	1,203	2,067	10	3,271	1,636
1932	58	2,831	1,047	1,792	8	2,829	1,650
1933	69	2,711	928	1,794	11	2,722	1,703
1934	75	3,176	990	2,210	23	3,199	1,238
1935	87	3,309	948	2,383	23	3,332	1,081
1936	103	3,675	938	2,752	15	3,690	1,008
1937	113	4,276	976	3,317	17	4,293	1,000
1938	89	3,101	832	2,275	6	3,107	960
1939	109	3,556	954	2,615	13	3,569	988
1940	125	3,775	1,056	2,763	44	3,819	1,075
1941	162	3,956	1,044	2,982	70	4,026	1,217
1942	199	3,847	967	2,921	42	3,889	1,126
1943	239	3,413	811	2,637	35	3,448	----------
1944	235	3,181	721	2,491	31	3,212	----------
1945	203	3,351	725	2,629	44	3,395	981
1946	170	4,235	773	3,490	28	4,263	839
1947	187	4,762	833	3,957	28	4,790	837
1948	192	5,243	876	4,395	28	5,271	893
1949	176	5,519	918	4,640	39	5,558	924
1950	200	5,832	1,013	4,863	44	5,876	1,033
1951	220	6,004	1,106	4,968	70	6,074	[1] 1,135

[1] Estimate.

Source: Production, imports, exports from the Bureau of the Census, U. S. Department of Commerce. Apparent consumption equals production plus imports minus exports. Newsprint capacity from the Bureau of the Census for certain years; other years from the American Newspaper Publishers Association.

TABLE 2.—*Estimated United States newsprint apparent consumption, production, imports, exports, and requirements, 1952–55*

[Thousands of short tons]

Year	FRB index of industrial production (1935–39=100) [1]	Apparent consumption	Domestic production requirements	Imports	Exports	Total requirements, domestic production plus exports
1952	240	6,430	1,440	5,050	60	6,490
1953	252	6,680	1,590	5,150	60	6,740
1954	260	6,830	1,665	5,225	60	6,890
1955	265	6,900	1,660	5,300	60	6,960

[1] These projected FRB indexes for 1952–55 were made by the Office of Business Economics on Aug. 10, 1951, and used in establishing newsprint production goal.

Source: Prepared by the Pulp, Paper and Paperboard Division, NPA.

TABLE 3.—*Newsprint: United States domestic production requirements, 1951–55 versus Jan. 1, 1951, capacity*

	Thousands of short tons
Jan. 1, 1951, capacity	1,096
1952 domestic production requirements	1,440
Deficit	−344
1953 domestic production requirements	1,590
Deficit	−494
1954 domestic production requirements	1,665
Deficit	−569
1955 domestic production requirements	1,660
Deficit	−564

CHART 1

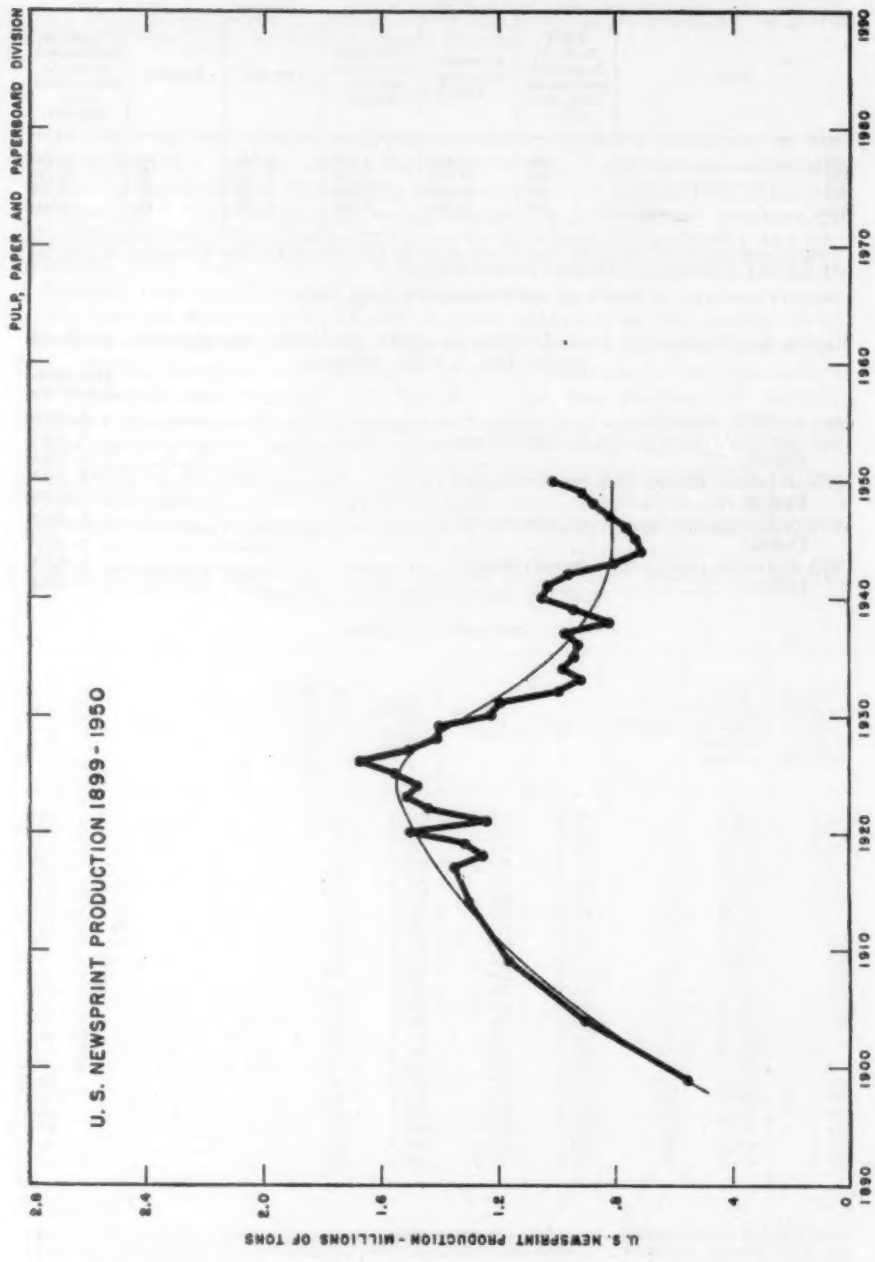
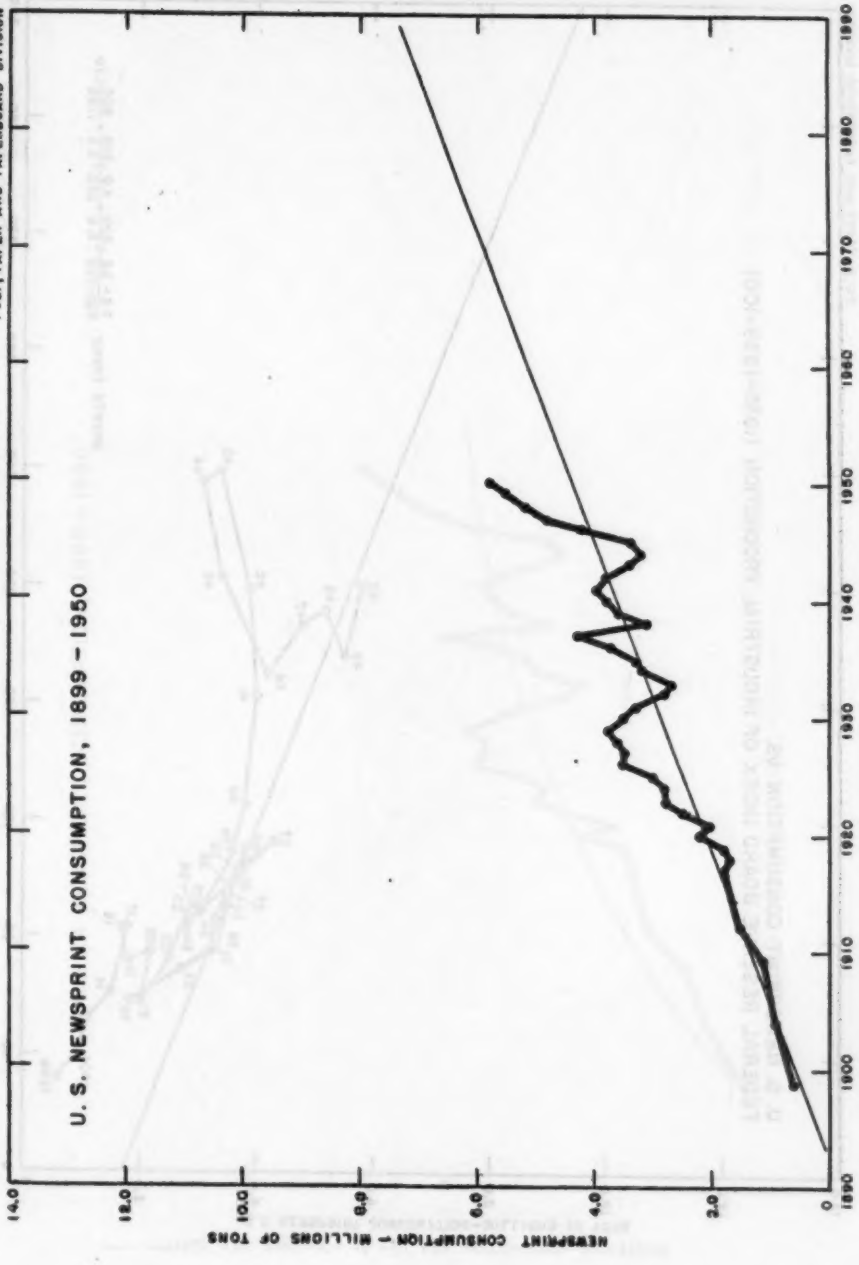
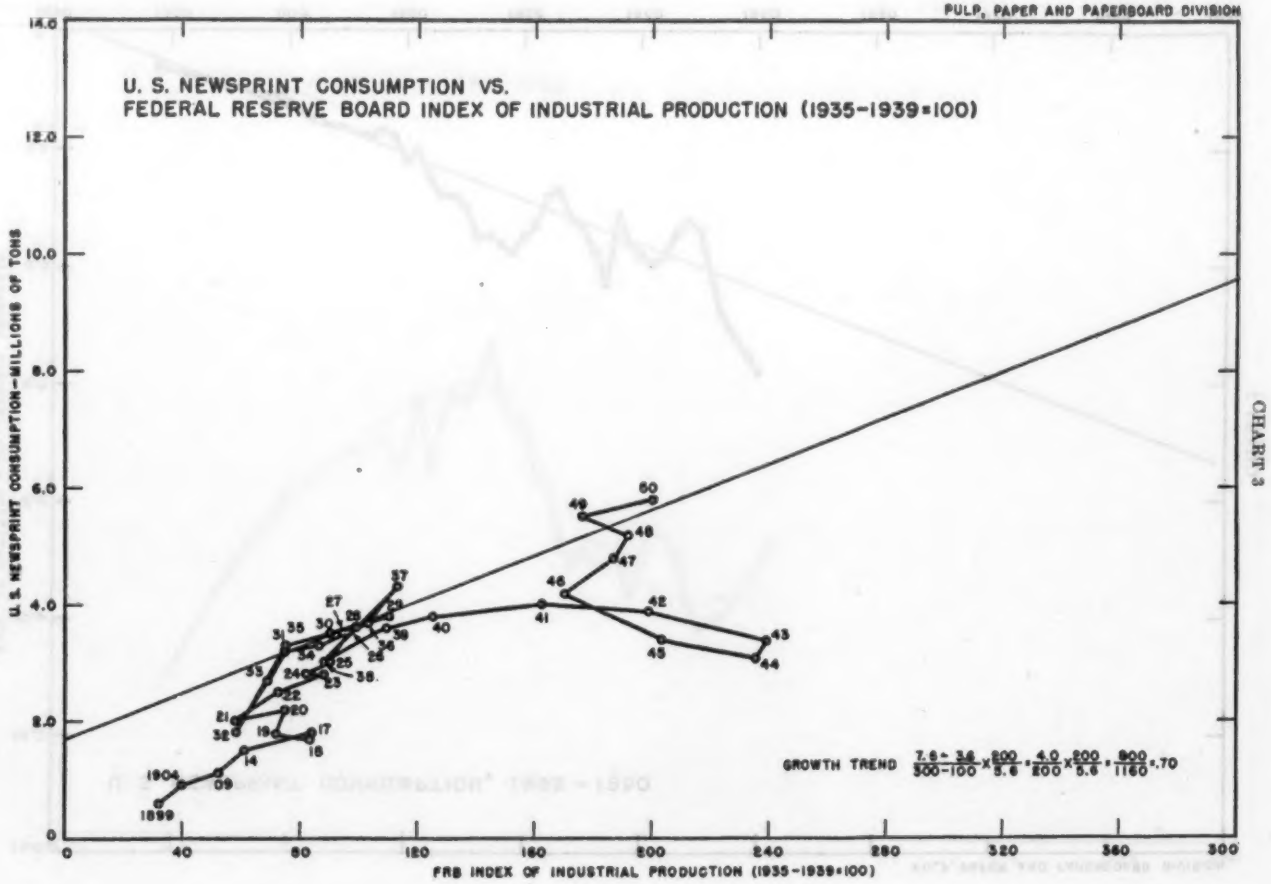

PULP, PAPER AND PAPERBOARD DIVISION
U. S. NEWSPRINT PRODUCTION 1899 - 1950
U. S. NEWSPRINT PRODUCTION - MILLIONS OF TONS
2.8
2.4
2.0
1.6
1.2
.8
.4
0
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990

CHART 2


PULP, PAPER AND PAPERBOARD DIVISION
U. S. NEWSPRINT CONSUMPTION, 1899 - 1950
NEWSPRINT CONSUMPTION - MILLIONS OF TONS
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990


PULP, PAPER AND PAPERBOARD DIVISION
U. S. NEWSPRINT CONSUMPTION VS.
FEDERAL RESERVE BOARD INDEX OF INDUSTRIAL PRODUCTION (1935-1939=100)
U. S. NEWSPRINT CONSUMPTION-MILLIONS OF TONS
FRB INDEX OF INDUSTRIAL PRODUCTION (1935-1939=100)
GROWTH TREND 7.6÷3.6/500-100 × 800/5.6 = 4.0/200 × 200/5.6 = 800/1160 = .70
0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
40
80
120
160
200
240
280
320
360
400
1899
1904
09
14
17
18
19
20
21
22
23
24
25
26
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28
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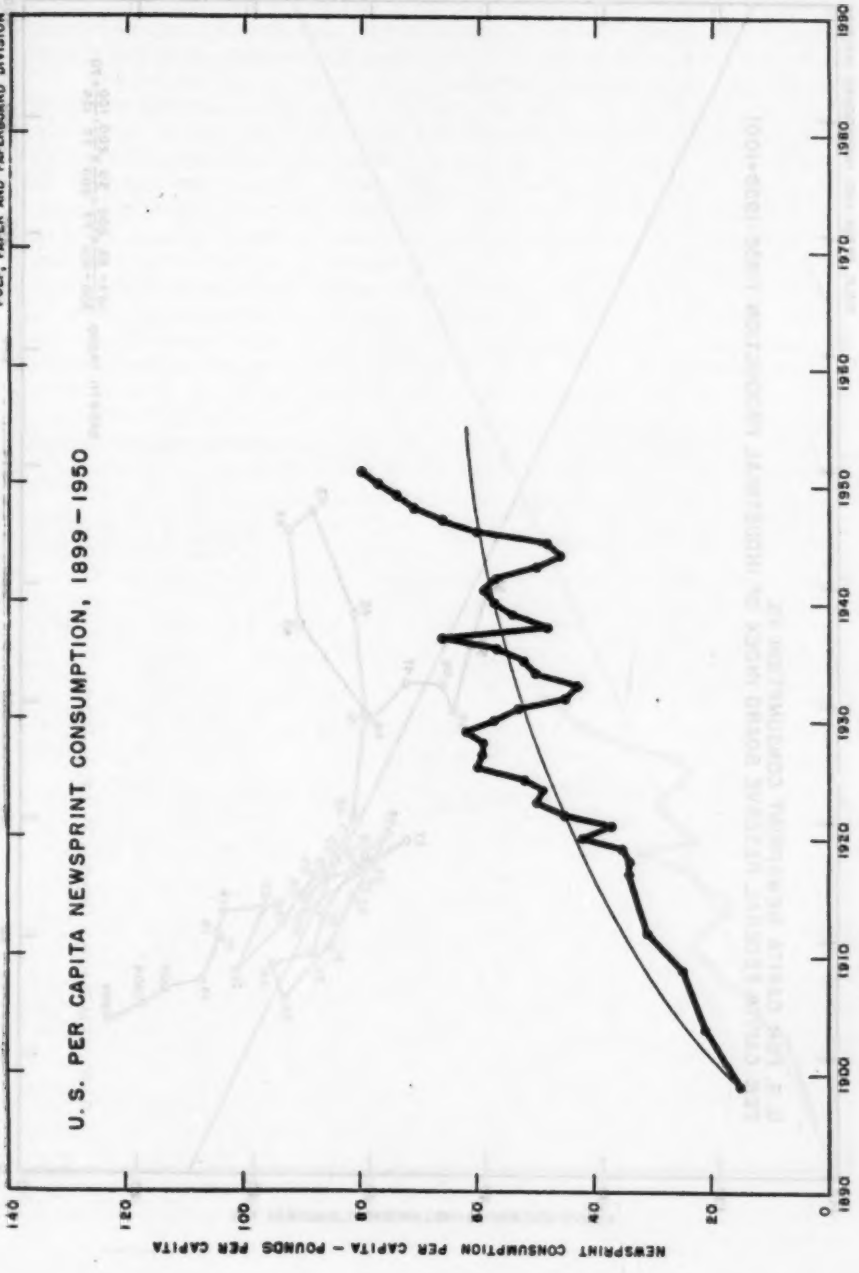
CHART 3

CHART 4


U. S. PER CAPITA NEWSPRINT CONSUMPTION, 1899 – 1950
PULP, PAPER AND PAPERBOARD DIVISION
NEWSPRINT CONSUMPTION PER CAPITA – POUNDS PER CAPITA
FRB INDEX OF INDUSTRIAL PRODUCTION (1935-1939=100)
0
20
40
60
80
100
120
140
160
180
200
240
280
320
360
400
1890
1900
1910
1920
1930
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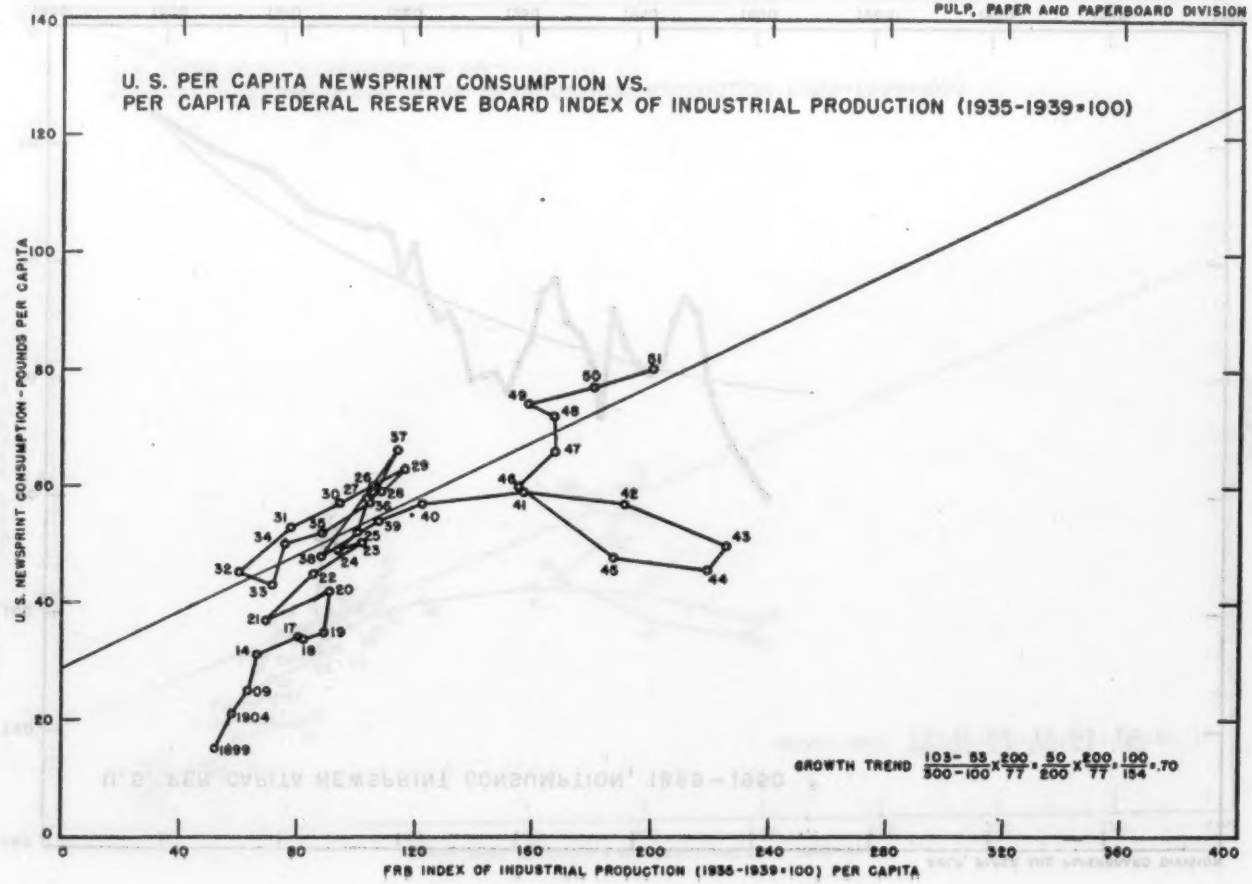
1950
1960
1970
1980
1990


PULP, PAPER AND PAPERBOARD DIVISION
U. S. PER CAPITA NEWSPRINT CONSUMPTION VS.
PER CAPITA FEDERAL RESERVE BOARD INDEX OF INDUSTRIAL PRODUCTION (1935-1939=100)
U. S. NEWSPRINT CONSUMPTION - POUNDS PER CAPITA
FRB INDEX OF INDUSTRIAL PRODUCTION (1935-1939=100) PER CAPITA
GROWTH TREND 103-55/500-100 X 200/77 = 50/200 X 200/77 = 100/154 = .70
1899
1904
09
14
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
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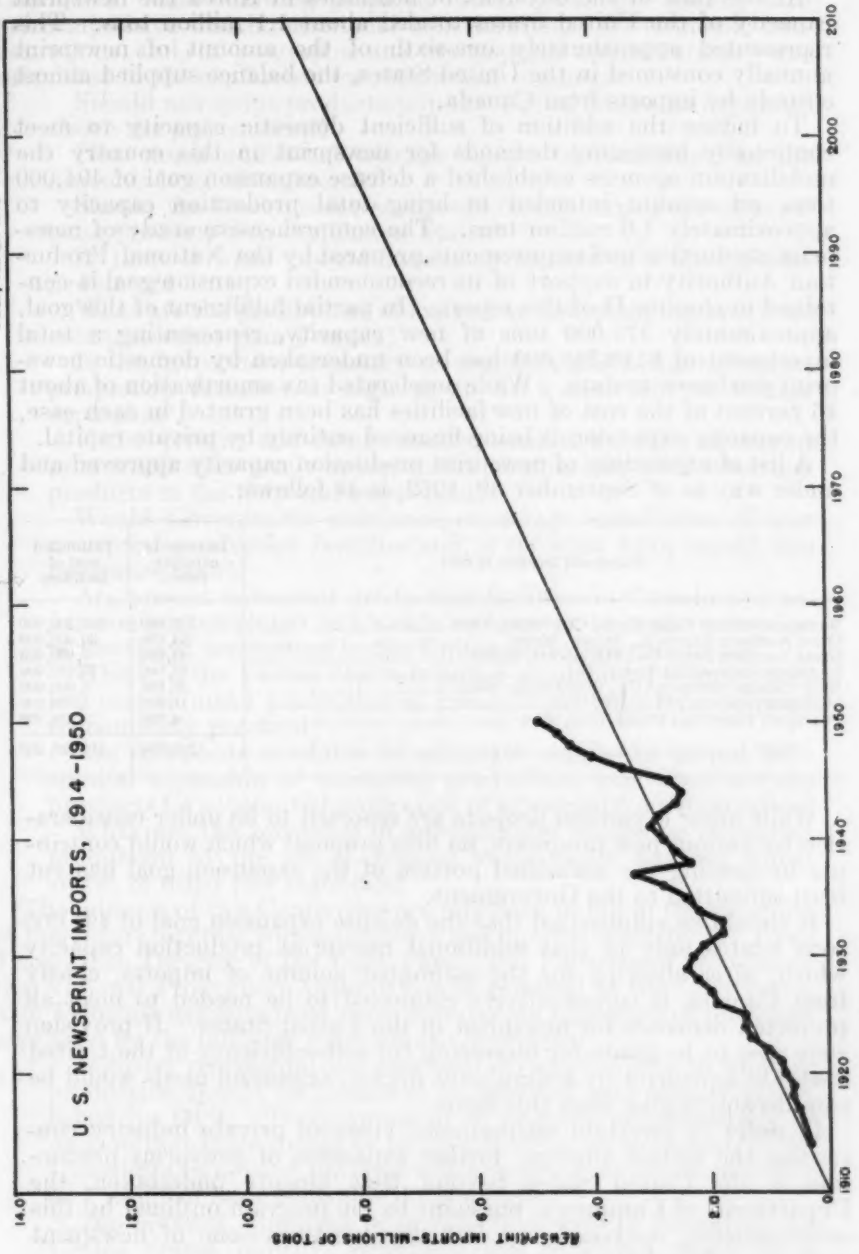
47
48
49
50
51

CHART 5

CHART 6


U. S. NEWSPRINT IMPORTS, 1914-1950
NEWSPRINT IMPORTS-MILLIONS OF TONS
0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
PULP, PAPER AND PAPERBOARD DIVISION

III. Factors Affecting Expansion

At the time of the outbreak of hostilities in Korea the newsprint capacity of the United States totaled about 1.1 million tons. This represented approximately one-sixth of the amount of newsprint annually consumed in the United States, the balance supplied almost entirely by imports from Canada.

To induce the addition of sufficient domestic capacity to meet continually increasing demands for newsprint in this country the mobilization agencies established a defense expansion goal of 494,000 tons, an amount intended to bring total production capacity to approximately 1.6 million tons. The comprehensive study of newsprint production and requirements.prepared by the National Production Authority in support of its recommended expansion goal is contained in chapter II of this report. In partial fulfillment of this goal, approximately 375,000 tons of new capacity, representing a total investment of $110,288,000 has been undertaken by domestic newsprint producers to date. While accelerated tax amortization of about 45 percent of the cost of new facilities has been granted in each case, the capacity expansion is being financed entirely by private capital.

A list of expansions of newsprint production capacity approved and under way as of September 30, 1952, is as follows:

Name and location of mill	Increase in capacity (tons)	Estimated cost of facilities
Bowater Southern Paper Corp., Charleston, Tenn	125,000	$51,500,000
Great Northern Paper Co., Bangor, Maine	124,000	30,000,000
Great Northern Paper Co., Millinocket, Maine	13,000	7,000,000
Southland Paper Mills, Herty, Tex	68,000	15,040,000
West Tacoma Newsprint Co., Steilacoom, Wash	30,000	5,000,000
Michigan Paper Co., Plainwell, Mich	11,000	1,500,000
Publishers Paper Co., Oregon City, Oreg	4,000	248,000
Total	375,000	110,288,000

While other expansion projects are reported to be under consideration by various new producers, no firm proposal which would contribute to meeting the unfulfilled portion of the expansion goal has yet been submitted to the Government.

It should be emphasized that the defense expansion goal of 494,000 tons relates only to that additional newsprint production capacity which, after allowing for the estimated volume of imports, chiefly from Canada, is conservatively estimated to be needed to meet all projected demands for newsprint in the United States. If provision were also to be made for increasing the self-sufficiency of the United States in newsprint by a significant degree, expansion needs would be considerably higher than this figure.

In order to ascertain all pertinent views of private industry concerning the factors affecting further expansion of newsprint production in the United States beyond that already undertaken, the Department of Commerce, pursuant to the program outlined by this subcommittee, convened two industry meetings—one of newsprint producers, the other of newsprint consumers.

Views of newsprint producers

On June 18, 1952, a special industry advisory conference was convened to which existing and prospective producers of newsprint in

the United States were invited. This conference was held under the auspices of the National Production Authority of the Department of Commerce. The following prepared list of questions—dealing with (*a*) competitive and international considerations; (*b*) economic considerations; and, (*c*) geographic and raw material considerations—was submitted to the conference for review and comment:

Should newsprint production in the United States be expanded above the present level?

How much additional tonnage should be established as the desirable level of expansion?

Should the Government encourage further expansion of newsprint production in the United States?

Is there a trend toward increasing exports of United States newsprint?

What are the possibilities of expanding newsprint imports from countries other than Canada?

Is the investment necessary to establish additional newsprint production facilities so high as to be a deterrent to further expansion?

Under present and future market conditions, does newsprint production offer profit opportunities comparable with other end products in the pulp and paper field?

Would Government assistance encourage installation of new newsprint production facilities and, if so, what form should this assistance take?

Are present newsprint production facilities in Canada and expansion contemplated in Canada so large as to make expansion of newsprint production in the United States uneconomical?

Where in the United States is power available at a sufficiently low cost to make production of groundwood pulp for newsprint economically practical?

Are softwoods available in adequate supply to permit substantial expansion of newsprint production, and what are the prospects for substantial production of newsprint from hardwoods?

What are the prospects of substantially increasing newsprint production by the use of deinked waste paper, bagasse, wheat straw, or other raw materials?

The minutes of this Conference are reprinted in full in the appendix to this report together with a summary and interpretation by Mr. Lyall Tracy, then Director of the Pulp, Paper, and Paperboard Division of the National Production Authority, who presided at the Conference. The following excerpts from these minutes are indicative of the views expressed by the industry representatives present:

Industry representatives expressed divergent views on whether production should be expanded beyond the goal already established by DPA. There appeared to be some preponderance of opinion that there should be no specific drive for expansion in the United States beyond the level which would come about naturally as a result of basic economic developments.

The greatest stimulant to increasing newsprint output in the United States, industry representatives concurred, would be a more favorable pricing structure. Because of the low rate of return on newsprint compared with other grades of paper, many manufacturers have shifted their production to more profitable

lines. Better prices on newsprint would induce producers to reconvert the machines to newsprint production, they believed. Also, if newsprint distribution were free from political intervention, they felt that the normal working of supply and demand would stabilize the situation.

Industry representatives cited actions and regulations of the Department of Agriculture, the Department of the Interior, and the National Park Service which, they said, have deterred increased production. Representatives from the west coast cited the withdrawal of timberland in the Northwest for the establishment of the Olympic National Forest. The area is inaccessible to the public, they said, but would provide a perpetual source of raw material sufficient to supply about 800,000 tons of newsprint a year. If this sustained yield of timber had been available for sale to private purchasers, additional newsprint might now be in production in the United States. Several industry representatives recommended that the Government consider releasing this valuable timberland to encourage the expansion of newsprint production in the United States.

Another source of a tremendous quantity of raw material lies in the Tongass National Forest, Alaska, an industry representative pointed out, but the exorbitant cost involved in complying with restrictions imposed by "preventive Government legislation" will not permit utilization of the material. If this timber had been available, additional newsprint might now be in production in the United States.

At present interest and tax rates, industry representatives concurred, new mills competing with established mills in either Canada or the United States would be at a substantial disadvantage.

It was the consensus of the group that capital investments in other pulp and paper products would be more profitable considering the low return on newsprint and the continuing political pressure brought on newsprint producers.

Under existing conditions investment of new capital in newsprint production facilities did not appear to be attractive in the opinion of most of the committee members. In those instances when unusual circumstances indicate the possibility of a successful expansion of newsprint production in the United States, existing forms of Government financial aid should not be withheld, but the committee did not feel the Government should extend financial assistance to the newsprint industry beyond that available to all types of industry in the country.

Unless timber now withheld from the market, as mentioned above, is made available, the preponderance of thought in the committee was that softwoods were not available to permit substantial expansion of newsprint in the United States. Also, power at a cost which makes newsprint production economically practicable is available only in a few limited geographic areas. The use of hardwoods in newsprint has not developed sufficiently to obtain an opinion from the committee as to whether that field of raw material offers a practical opportunity for large scale newsprint production.

Developments thus far in the use of fibrous materials other than wood do not lead the committee to expect large scale newsprint production from such materials.

Views of newspaper publishers

On June 26, 1952, the problem of expanding newsprint production in the United States was considered by a representative group of newspaper publishers composing the Newspaper Industry Advisory Committee of the National Production Authority of the Department of Commerce. The views and comments of this group were submitted with respect to the following prepared list of questions:

In November 1951 a Defense Production Administration expansion goal for 494,000 tons of additional newsprint production was approved. To date, only 375,000 tons of additional production has been proposed in tax amortization applications. In view of these facts, would you recommend that any change be made at this time in the present goal?

Would you recommend that the Government take further steps to encourage expansion of newsprint production in the United States? If so, what steps do you suggest be taken? If not, why not?

To what extent are newspaper publishers willing to finance further expansion of newsprint production in the United States?

Would you recommend that the Government give financial help other than tax amortization, either separately or jointly with newsprint producers or consumers?

What are your views as to the practical prospects for newsprint made from materials other than pulpwood, such as de-inked paper, bagasse, or wheat straw?

The full minutes of this Advisory Committee meeting are reproduced in the appendix material of this report. The following excerpts summarize the principal views expressed:

A committee spokesman expressed the opinion that not since 1900 has the domestic supply of newsprint been sufficient to meet the needs of the United States. The majority of the committee concurred in the view that the planned tonnage will be absorbed regardless of newsprint conservation programs that have been undertaken, rising prices, or any other considerations.

Certain members of the committee strongly emphasized that no person who wished to enter the newsprint-production field should be deterred from doing so because of the fact that the planned goal had been reached.

The committee recommended that a study be made of the possibility of utilizing pulpwood, timberlands, such as those on the Olympic Peninsula and in Alaska, for the production of forest products, including newsprint, under proper restrictive safeguards which would assure the perpetuation of the natural resource.

The committee was generally of the opinion that newspaper publishers would provide reasonable amounts of equity capital to start new mills. Members wished to withhold a definite commitment as to the extent of the investment until a specific offering is made.

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Many factors would influence such an investment, committee members explained. Capital investments in other paper products provide a better financial return than newsprint, it was pointed out. It was generally believed, however, that publishers would invest in newsprint mills if the raw materials for newsprint production were available.

The committee stated that it is not opposed to Government loans per se but that the newspaper industry will not seek them and will avoid any which might affect the independence of the newspaper business.

The committee concluded that de-inked paper, bagasse, and wheat straw are not as yet practicable substitutes for pulpwood in the production of newsprint.

IV. Availability of Timber for Newsprint

One of the principal obstacles to further expansion stressed by newsprint producers is the Nation-wide shortage of softwood timber, which is now the source of virtually all of the wood going into newsprint production.

The seriousness of this shortage at the present time is confirmed by data prepared by the Forest Service of the Department of Agriculture. A detailed review of the situation with regard to pulpwood, submitted to the Department of Commerce in connection with the investigation for this subcommittee, is appended to this report. The findings contained in that review may be summarized as follows:

1. The pulp and paper industry is in direct competition with the lumber industry and many other wood-using plants for its wood requirements, particularly for softwoods which are preferred for newsprint.

2. Preferred softwood species are being heavily overcut, whereas hardwoods are in general increasing. This overcutting of softwoods is of particular significance to the pulp and paper industry since about 86 percent of the total cut of pulpwood, and essentially all the wood used for newsprint, is comprised of softwoods.

3. The pulp and paper industry has been acquiring land at a rapid rate in recent years and now owns possibly 20 million acres, or about 4 percent of the commercial forest lands in the United States. It has become increasingly difficult to block up timber properties of efficient size, however, primarily because of the small size, high cost, and scattered location of timber holdings that are for sale today. Any new newsprint mill in the United States, therefore, faces a serious problem of acquiring sufficient timber land to supply a substantial part of its own wood requirements.

4. In the Northeastern and Lakes States, which together supply about 25 percent of pulpwood cut in the United States and more than half of the domestic output of newsprint, there appears to be little opportunity for expansion of newsprint or other paper based upon the use of softwoods.

5. Further expansion of the pulp and paper industry in the South must be carried out in the face of declining supplies of available southern pine timber. There will probably be further expansion of the pulp industry in the South, but such expansion must be at the expense of the timber resource or the lumber industry and other

wood-using plants, unless the timber raw material supply situation is materially improved through better forest management, more intensive utilization of woods and mill waste, or the use of hardwoods in lieu of softwoods.

6. On the west coast, where about one-third of the domestic newsprint is produced, timber supplies are available for increased pulp and paper production based primarily upon the use of Douglas-fir sawmill and logging waste, and upon little used species such as lodgepole pine. However, these species are primarily suitable for kraft pulp rather than for the groundwood pulp normally used in newsprint. Substantial volumes of the former "pulping" species such as western hemlock, fir, and spruce still remain, but such timber is mostly blocked up in public or large private holdings, and competition has become increasingly keen for these species upon which the pulp and paper mills in this region, including newsprint mills, have largely drawn in the past.

7. Although promising from a timber-supply standpoint, locations in the Rocky Mountain area in the past have not been considered as especially promising because of such factors as distance to markets, high costs of logging, and problems of water supply.

8. The best opportunities for expansion of the domestic newsprint industry are to be found in the softwood forests of Alaska and the hardwoods of the eastern United States. In most other areas, further expansion of the pulp and paper industry based upon species conventionally used is likely to have serious impacts either upon the timber resource or upon other wood-using industries.

ALASKA

The problems affecting access to Alaskan softwoods, particularly in the national forests of southern Alaska, merit careful consideration. There is now under construction at Ketchikan, Alaska, a new wood-pulp mill, estimated to cost over $40 million, utilizing timber from the Tongass National Forest under a 50-year contract. Timber supplies and suitable plant sites are reported to be available for several additional large-size mills.

The timber-supply opportunities in Alaska in relation to expansion of newsprint production have been extensively studied and reported by the Forest Service of the Department of Agriculture. As submitted by that agency to the Department of Commerce, these factors are essentially as follows: (*a*) The 5 million acres of commercial forest land in the national forests of southeastern Alaska support an estimated stand of 84 billion board feet, which could support permanently production of 1 million tons annually of pulp and paper, plus some lumber and other timber products. (*b*) Alaskan timber, consisting of about three-fourths hemlock and one-fourth spruce and other species, is especially suitable for the manufacture of newsprint. (*c*) Large water-power resources can be developed far in excess of possible demands of newsprint mills. (*d*) Adequate supplies of suitable water are also available at numerous mill sites. (*e*) A logging season of 9 to 10 months is feasible in this region. (*f*) The tidewater location of prospective mills and the feasibility of water transportation by the protected Inside Passage favors low transportation costs for manufactured products. (*g*) Adequate timber is available for large new

pulp mills in Alaska on terms that will safeguard the public interest and also provide reasonable security to plant investments.

Newsprint producers have alleged that in view of extremely high labor costs in Alaska at the present time the present regulation of the Department of Agriculture requiring that timber cut from the national forests of Alaska be given at least primary manufacture before shipment from the Territory serves as an effective deterrent to the use of these timberlands for newsprint production. This regulation, which is supported by the Territorial government of Alaska, is intended to promote the economic development of Alaska on a sound basis. The Department of Agriculture has pointed out that under the present regulation it would be possible to manufacture groundwood and chemical pulp in Alaska for shipment to newsprint mills located in the States.

The timber supply potentiality of Alaska for expanded newsprint production is so great that every effort should continue to be made to find an effective solution which will permit economic access to the forest on a basis compatible with national resource and Territorial policy.

HARDWOODS

Most of the newsprint used in the United States at the present time consists of about 80 percent groundwood pulp derived from softwoods, with the remainder consisting of chemical pulp, also derived chiefly from softwoods.

Spurred by the continually growing shortage of softwood timber, great strides have been made in recent years in developing technologies for utilizing hardwoods in the manufacture of newsprint. The Forest Products Laboratory of the Department of Agriculture and the New York State College of Forestry have pioneered in this movement in the United States. While a considerable body of technical information on this subject is now available, and developments to date offer bright promise, hardwoods are not yet used to a significant extent in commercial newsprint production in the United States. In this respect the United States has lagged behind commercial developments abroad, particularly in Italy and Australia.

In both of these countries, hardwoods are being used to a major extent in successful large-scale commercial newsprint operations. Both use fast-growing hardwoods for production of the necessary mechanical pulp, and both of them cultivate their hardwoods as a crop. In Italy a fast-growing hybrid poplar is used, whereas in Australia certain selected species of eucalyptus are used.

A brief review of developments in Australia and Italy, as reported by the Mutual Security Agency, is given below.

Developments in Australia

Some of the most intensive and most important work on the use of short-fibered hardwoods has taken place in Australia. Due to the fact that the Australians have no significant quantity of conifers, they have been compelled to build up a pulp and paper industry almost entirely on their short-fibered hardwoods, consisting principally of various selected species of fast-growing eucalyptus.

After suitable varieties were chosen, there followed a long period of intensive development toward production of both chemical pulp and

mechanical pulp from eucalyptus. The problems involved in the production of mechanical pulp and the subsequent production of newsprint from eucalyptus proved to be extremely difficult to solve. However, after a tremendous amount of work, including commercial test runs at the Crown Willamette newsprint mill at Ocean Falls, British Columbia, the technical problems were all solved.

A group of Australian newspapers then decided to provide the necessary capital for the construction of a newsprint mill. At the same time they signed contracts to share the output in proportion to consumption on a cost-plus basis. Boyer, Tasmania, was chosen as the site, because there was abundant hydroelectric power, the Derwent River provided plenty of water the year around, there were large stands of suitable pulpwood within reasonable distance, and some of the principal chemicals used are manufactured only a few miles away.

Manufacture of newsprint from eucalyptus started in 1941. The paper produced was scarcely distinguishable from Canadian newsprint and the mill was a huge success from the start. The capacity of this first machine was about 30,000 tons. From 1941 to 1945, this Boyer mill produced approximately as much newsprint as was imported, and in fact it saved the Australian press from near extinction during the war. In addition, the domestic production has been of great benefit to the Australian economy in the postwar period of dollar shortages.

Perhaps the most remarkable technical achievement in this entire project has been the speed attained on the newsprint machine. By using a furnish containing 80 percent eucalyptus mechanical pulp and 20 percent imported softwood chemical pulp, newsprint is being produced at speeds up to 1,250 feet per minute. Furthermore, the Australian technicians confidently expect that development work now going on will make it possible to operate their newsprint machines at the same speed as the leaders in the United States and Canada. They hope to do this by using mechanical pulp and semichemical pulp from short-fibered eucalyptus, plus the regular proportion of long-fibered (softwood) chemical pulp.

As a result of the outstanding success with the first machine, Australian Newsprint Mills, Ltd., decided in 1948 to expand their production by installing a new, large, completely modern high-speed newsprint machine. The second machine has a trim width of 246 inches and the aim was to increase the total output to 80,000 long tons by the end of 1950. It was estimated that wood resources on Tasmania would support a production of 100,000 tons per year.

The expanded plant was ready for operation by the end of 1950. Unfortunately Tasmania, at the time the plant was completed, had been suffering from severe droughts and the hydroelectric power supply was curtailed drastically. This dry condition has persisted throughout the past 2 years and as yet it has not been possible to put this new capacity to work. Power has been available only for operating the smaller machine, or its equivalent production when it is desirable to switch to the big machine. Therefore, Australian output is still only about 31,000 long tons per year. However, the research and development work continues, and as soon as power is available the Australian production of newsprint will be increased to 80,000 long tons per year, or almost one-half of the total annual consumption.

Developments in Italy

In Italy almost all of the mechanical pulp used in the manufacture of newsprint is produced from a fast-growing hybrid poplar. For the past 20 years poplar has been grown in Italy as a crop. The Experimental Institute for Poplar Cultivation, owned by the Burgo Paper Mills, the largest newsprint manufacturer in Italy, has been greatly responsible for the success of this project. This organization has worked on development of improved strains of hybrid poplar trees which are resistant to decay and to all forms of fungi diseases to which poplar trees are particularly susceptible. In this field they have made outstanding progress.

The Institute now grows great quantities of small trees which are distributed to the farmers for planting and cultivation on their small plots of ground. This part of the program has been particularly successful since, by proper spacing, these trees can be planted along with other crops in the fields and the farmer is still able to grow his food crops such as corn, potatoes, wheat, and cereals. The trees grow to pulpwood size in 10 to 12 years, and the farmer realizes additional income from this tree crop.

During 1951, Italy produced about 115,000 short tons of newsprint paper, with mechanical poplar pulp accounting for 50 to 70 percent of the total. The poplar wood has a good white color, is ground easily, and it produces a pulp of good quality. By using poplar for all of the mechanical pulp, it is possible to save the scarce softwoods, such as spruce and fir, for production of chemical pulp.

In order to obtain reliable technical, economic, and operating data with which to appraise the feasibility of enlarging the use of hardwood pulp for newsprint production in the United States, the Mutual Security Agency and the Department of Commerce have jointly sent a special team to Europe to make a first-hand investigation of developments in hardwood utilization for newsprint. As part of this assignment, a complete study was made of the technology and economics of newsprint production from hardwoods in Italy, including a detailed analysis of raw material and production costs. The report of this mission is now being reviewed, and the findings and conclusions of the investigation will be submitted by the Department of Commerce in its next progress report to this subcommittee.

V. Bagasse as a Raw Material for Newsprint

One of the major activities carried on by the Department of Commerce in accordance with the program requested by the subcommittee has been an independent investigation of the potentialities of using sugarcane bagasse as a raw material for making newsprint.

Bagasse was selected for initial study in this program primarily because of the extensive history of research and developmental activity which had already gone into its use as a paper-making material. There are at the present time a number of mills in various areas of the world utilizing bagasse as a raw material in the manufacture of a variety of paper products other than newsprint. Numerous uncertainties, however, have surrounded the question of technical and economic feasibility of using bagasse as a raw material for newsprint.

TECHNICAL INVESTIGATION

Among the most important scientific and technical contributions in this country in the field of developing economic uses for bagasse have been those made by the Northern Regional Research Laboratory of the Department of Agriculture at Peoria, Ill., under the direction of Dr. E. C. Lathrop and his associates. This work has been performed over many years as part of a continuing program of the Department of Agriculture to develop sound commercial outlets for agricultural residues.

A substantial part of the investigations concerning bagasse have been focused upon the removal of pith from the sugarcane fibers and developing economic uses for the separate materials. Although the conclusions of some technicians have suggested the unsuitability of pulps made from bagasse for newsprint uses, except to a limited extent in blending pulps made from depithed bagasse with other pulps, conflicting reports often based upon the same evidence have appeared. Repeated claims have been made, particularly in recent years, that a pulp satisfactory for newsprint manufacture can be made from undepithed or whole bagasse exclusively. Claims have also been put forth that technical processes using whole bagasse as a raw material for newsprint are advanced to the state of readiness for commercial operation.

A number of congressional committees and private agencies in the past have urged that the basic technology and economic support for such claims be objectively examined. So far as can be determined, however, until the investigation sponsored by this committee, no newsprint had been made from bagasse on a laboratory or pilot scale which was considered satisfactory for newspaper use in all respects without qualification; nor had constructive action been taken which would permit a conclusive definition of the value of bagasse as a raw material to make newsprint.

In order to provide a sound basis for future policy decisions in this sphere as requested by the subcommittee, it was necessary to ascertain as definitively and as objectively as possible the merits of conflicting claims. Accordingly, the Department of Commerce decided to use the pilot paper mill at its own National Bureau of Standards as a proving ground for these claims, obtaining the cooperation of other agencies of Government as need arose.

PROCESS TRIALS

A series of trials was conducted at the National Bureau of Standards involving the conversion of raw bagasse obtained from Louisiana into finished newsprint by a number of different processes, accompanied by exhaustive tests of the results at every stage of the operation. The intended purpose of these trials was as follows:

1. To determine whether satisfactory newsprint can be made on a pilot scale by any existing process under conditions completely supervised by Government personnel from raw material to finished product.
2. To ascertain whether existing proprietary or patented processes for making bagasse into newsprint are significantly

different from standard processes known to the paper-making art and contribute something of value to the art for the use intended.

3. To determine whether satisfactory newsprint can be made from bagasse without prior removal of the pith.

4. To compare the results achieved by the different processes, and to test the newsprint made by each process for the physical qualities which determine acceptability for newsprint use.

5. To obtain technical and operating data as a basis for making judgments as to production costs in comparison with standard newsprint.

6. To evaluate the nature of the various technical processes in terms of practicability for commercial operation.

This program was not one of new process development in any sense. It was limited, by definition, to the testing of already existing processes. It was only necessary to find out what these processes were, how they operated, and then to perform the operations at the National Bureau of Standards pilot paper mill.

Accordingly, all known proprietors of processes for making paper for newsprint from whole bagasse were invited to participate in this program. The conditions for participation were these:

1. Full declaration and disclosure of all details of the process would be made to the Department of Commerce in each case, with the understanding that such matters as were regarded as trade secrets would not be revealed at any time by the Department of Commerce.

2. Tests of processes would be made at the National Bureau of Standards using the equipment as installed, the personnel of the Paper Section, and under the supervision of the Department of Commerce.

3. Representatives of the proprietors were invited to be present in an advisory capacity during the trials of their processes and to give such help in operation as was considered appropriate by the Department of Commerce.

4. The Department of Commerce alone was responsible for conducting all tests, maintaining all records, evaluating all results, and reaching all conclusions as to the products and processes tested.

5. All data, results, interpretations, and conclusions, excepting only trade secrets as agreed upon, were to be submitted to the subcommittee for full and complete publication.

The complete report of the Bureau of Standards containing all data and findings based upon these trials is appended to this chapter.

PROCESSES TESTED

A total of seven procedures were tested at the Bureau of Standards, of which four were patented or "proprietary" processes for making newsprint from bagasse. These proprietary processes formed the essential subject matter of the trials. For control purposes, three "standard" processes were similarly tested, two involving the use of bagasse and one of wood.

All the bagasse used in these tests was taken from a supply furnished by the New Iberia Sugar Cooperative, New Iberia, La.

Proprietary processes

Proprietors of processes for making newsprint from whole bagasse who were invited to participate, acquiesced in the conditions for trial, and agreed to participate, were:

De La Roza Corp.: Joaquin De La Roza, Sr., president, 106 Wall Street, New York, N. Y.

Valite Corp.: W. J. Amoss, executive vice president, Whitney Building, New Orleans, La.

Chemcel Corp.: Frank Hayes, vice president, 4538 West 130th Street, Cleveland, Ohio. (This company is the operating unit for Kinsley Chemical Co. of the same address.)

Mr. H. L. Horn, 135 Front Street, New York, N. Y.

Control processes

For purposes of comparing proprietary processes and products with developments already well-known to the art, three tests were made.

1. Paper was made from whole bagasse using a Kraft digestion process.

2. Paper was also made by the Kraft digestion process from depithed bagasse.

3. In order to establish a criterion for comparison of the engineering data on these processes with a process using materials familiar to the pulp and paper industry, paper was also made from loblolly pine chips. A standard sulfate digestion was used for this process.

Equipment

The equipment used in all tests was, for the most part, already installed at the Bureau of Standards and was of the kind regarded as common to the art.

The small rotary digestor was of a capacity suitable for treating in batches 75 to 100 pounds of raw bagasse and 100 pounds of wood chips. The digestor was supplied with steam lines and appropriate means for injecting chemicals. Vanes were installed in the digestor to insure adequate mixing of the contents, and the entire unit was repaired to insure satisfactory performance.

Suitable dump tanks, equipped with drainage screens, were built and installed. Beater capacity was sufficient to process several batches of cooked pulp. All lines and connections were cleaned after each use to insure against mixing of successive batches.

The paper machine has been described in publications of the National Bureau of Standards. It offers no exceptional advantages over other similar installations and may be regarded as commonplace in all particulars.

Because most of the processes required such equipment, a suitable chlorinating unit was provided. The design was that of the Hooker Electrochemical Co. for the chlorinator installed at the Herty Foundation Laboratory in Savannah, Ga. With minor modifications this unit was built and installed by the shops of the National Bureau of Standards.

Other equipment was supplied by proprietors. A Sprout-Waldron disk refiner was loaned by the Valite Corp. However, there was nothing critical about its use and it cannot be said that this is a necessary unit for the successful operation of any process investigated.

A laboratory-size rod mill was loaned by Mr. H. L. Horn. This unit was found to be of insufficient capacity and contributed nothing of technical or test value to the investigation of the Horn process.

Analyses and tests

Analyses and tests consisted in the physical and chemical determination of properties and content of the pulps and papers made at the Paper Section. They were performed at the laboratories of the National Bureau of Standards by Bureau technicians. The object was to obtain as much information as was practical to aid in the evaluation of the products.

The physical tests which were used are all well known to the art and have been described in detail in the technical literature. Included are weight of paper, thickness, bursting strength, folding endurance, tensile strength, tearing strength, smoothness, ash, opacity, fiber composition.

The pulps after bleach were examined for freeness by the Schopper-Riegler method and analyzed for alpha-cellulose, beta- and gamma-celluloses, lignin, pentosans, and ash. The raw bagasse, the depithed bagasse, and the loblolly pine chips, all as received, were similarly analyzed and, in addition, a determination made for soluble extractives. Results are given in the accompanying tables. Procedures were those of the Technical Association of the Pulp and Paper Industry.

An investigation into the nature and distribution of fiber and pith of the bleached pulps was undertaken by microscopic examination. Photomicrographs illustrating the statistical results were made. The procedure consisted in preparing several slides, generally 5–8, and examining them at random to ascertain what was typical. Then followed a selection of 10–15 typical fields for study. This consisted in counting the number of fibers, whole pith cells and pith fragments and obtaining an average for all fields examined. As variations from the mean were small, the results may be regarded with confidence.

Description of processes

The proprietary processes are outlined in the order in which they were investigated. The exact specifications are given in the table of operating conditions and materials in terms of pounds per 100 pounds of whole bagasse as received from Louisiana.

1. *De La Roza process.*—The raw bagasse was "dusted" to remove gross dirt. The weight loss for this operation was placed at 10 percent. The rotary digestor was charged and a steam prehydrolysis was performed. The unit was drained. This was followed by a Kraft digestion in the same unit. The crude pulp was drained and stored in the chest of the paper machine where it was washed. The pulp was transferred to the beater where it was bleached with calcium hypochlorite, thoroughly washed, the furnish added and adjusted respecting pH, and the paper made.

The process involves nothing in equipment or chemicals used which would present unusual problems in commercial operation. No process difficulties were observed at any time. From raw bagasse to finished paper, the evidence leads to the conclusion that the procedure can be duplicated in commercial equipment and essentially the same product obtained.

2. *Valite process.*—The raw bagasse was dusted to remove gross dirt. The rotary digestor was charged and a short prehydrolysis provided. Besides heat, the prehydrolysis involved the use of a chemical, the identity of which is not here disclosed. The chemical offers no recognizable problems in use or effect on equipment and consitutes no significant part of operation costs. The pulp was then drained and thoroughly washed with water.

The digester was charged and the alkaline liquids admitted under closely controlled conditions. The details of this operation are not revealed here. It can be reported that the chemicals costs were comparable to those for caustic; the controlled addition offers no problems in execution and involves only a negligible expense.

The pulp was then dumped, drained, thoroughly washed, and chlorinated in the closed system. A caustic extraction and hypochlorite bleach followed. The furnish was added in the Jordan and the paper then made.

The process involves no equipment of an impractical nature and no expensive chemicals. The experience at the Paper Section indicates that desired results are not readily reproducible with certainty. This may be due to a high degree of sensitivity to minor variations in process, or to the fact that the bagasse used was significantly different from the bagasse with which the company had worked in the past.

3. *Chemcel process.*—Raw bagasse as received was used without dusting. This was charged into the rotary digester and a mild Kraft digestion followed. The chemicals required are caustic and K chemicals, a proprietary product offered for sale by the company for this purpose. The composition of K chemicals is not revealed here. They are, however, commonplace chemicals, being neither rare, costly, nor unusual.

After draining, the pulp was washed for 4 hours and then stored. Chlorination was effected in the closed system and the pulp then neutralized and washed. The furnish was added in the beater and the paper made.

The composition of K chemicals is the only secret thing about this process. Nothing unusual is involved. Process details are worked out with precision and there is every reason to expect that results can readily be duplicated.

4. *H. L. Horn process.*—This process is understood to be that as revealed in United States patent 2,446,418 and as further described in The Sugar Journal, December 1949, pages 8–11. As described by Mr. Horn and his colleagues, E. E. Litkenhous and H. M. Phillips, on July 18, 1952, to the Department of Commerce, the procedure to be followed at the Paper Section included these basic steps:

1. Operation of a rod mill to macerate the raw bagasse.
2. Separation of the pith from fiber by means of a revolving screen.
3. Digestion of pith and fiber separately and separately chlorinating and bleaching pith and fiber.
4. Blending of the separate pulps made from pith and fiber in preparation for making paper.

A detailed statement of these proposals, together with details of operation, was signed by Mr. Horn and his associates. It was understood that considerable latitude respecting the consummation of details was permissible.

To this end, a small rod mill and a screen were transported from the laboratory at Vanderbilt University to the Paper Section and appropriately installed.

In practice, it was found that the rod mill was not suitable for this task, whether because of inadequate capacity or other reasons was not demonstrated. Of the pulp ultimately made, 9.2 percent derived from the rod mill and, of this amount, a third was discarded. Permission was granted for pulp to be made using the Sprout-Waldron disk refiner. The product was not separated in the revolving screen. It was admitted immediately into the digester without separation into pith and fiber. Of the total pulp made, upward of 90 percent derived from this second procedure. Mr. Horn feels that this operation consummates the spirit and intention of his invention as disclosed, described, and specified on July 18, 1952.

The procedure as actually practiced at the Paper Section consisted in a short alkaline digestion of whole bagasse at low temperature, followed by a three-stage chlorination-bleach. The procedure is extremely simple and bears no discernible resemblance to the highly organized operation as proposed, and identifiable as the Horn process. No evidence of consequence was obtained from which to estimate the possible value of the Horn process as revealed in the literature and proposed for trial by Mr. Horn. The procedure as followed offers nothing significantly different from the art as it is generally known and test of invention was not involved.

5. *Control processes for whole and depithed bagasse and loblolly pine.*—Methods of operation for applying standard processes to whole and depithed bagasse were those suggested by the Northern Regional Research Laboratory. Although these procedures were not recommended as suitable for producing newsprint from bagasse, it is understood that the suggestions represent what is believed to be generally common to this art. As such, a base is provided for comparing proprietary processes from a technologic point of view and for relating the significance of the process contributions of the inventors to the common art.

In the control process, whole bagasse was not prehydrolyzed. It was charged into the digester and a standard Kraft digestion followed. The pulp was washed, chlorinated in the closed system, neutralized, washed, given an alkaline extraction in the beater, washed, given a hypochlorite bleach, washed, the furnish added and the paper made. The procedure is simple and offered no difficulties.

Depithed bagasse was processed as received from the Northern Regional Research Laboratory. This was made from the same supply of bagasse that was used for all trials by the National Bureau of Standards. Pulp was made exactly as described for whole bagasse.

Loblolly pine chips were supplied by the P. H. Glatfelter Co. The procedure was suggested by the Forest Products Laboratory. The object of this test was to ascertain recoveries of the system at the Paper Section for comparison with commercial operation. Serious variation might be attributed to system losses or excessive hydrolysis peculiar to the small rotary digester. A standard Kraft cook was provided without prehydrolysis, a chlorination and bleach, all following very closely what is understood to be standard practice.

The yield of pulp from loblolly pine as obtained at the Paper Section was 41.4 percent. This compares with commercial yields of as much as 48 percent. A correction of all values of as much as 16 percent may be justified on this basis. However, no such correction was made.

RESULTS OF TRIALS: PAPER

Many criteria determine the value of paper for use as newsprint. Essentially these are reducible to the following main categories: (1) strength, (2) opacity, (3) printability, and (4) pliability.

1. *Strength.*—Detailed data relating to the physical attributes of the papers made at the Paper Section are given in table 1 of Bureau of Standards report. For comparison and reference, the same tests are reported for standard commercial newsprint used by three leading newspapers: The New York Times, the Washington Post, and the Washington Evening Star. The results are summarized below:

Summary of strength of papers (see table 1)

	Standard newsprint	Paper from bagasse	Paper from pine
Folding endurance:			
Machine direction	4–5	7–45	44
Cross direction	1	5–18	14
Tensile strength:			
Machine direction	2.2–2.4	2.7–4.1	2.7
Cross direction	1.2–1.3	1.8–2.6	1.5
Tearing strength:			
Machine direction	19	19–25	42
Cross direction	22–23	18–43	66
Bursting strength	7	18–13.5	12

In all regards, papers made from bagasse are as strong as or stronger than standard newsprint. A part of this greater strength is desirable, especially in folding endurance and tear. As a group, bagasse produces a paper which is of such high quality that it may be said to be unnecessarily high for newsprint use.

Of the proprietary products, all would be suitable for newsprint upon the basis of strength alone.

The paper made by H. L. Horn's procedure is unsuitable respecting thickness, being 0.0041 inches, with weight at 42.8 pounds per 500 sheets (24 by 36 inches). The commercial thickness is 0.0032 to 0.0037 inches and the commercial weight from 32 to 34 pounds. In this regard the Valite product is preferred, while that of Chemcel is somewhat heavy. The paper made by the De La Roza process is slightly, although not significantly, heavy. This can readily be adjusted if desired because of the relatively high opacity.

2. *Opacity.*—This factor is of great importance and is used as a significant criterion of the property of a newsprint to be printed on both sides without interfering with legibility. Commercial newsprints generally have an opacity of 90 while 88 is sometimes regarded as the permissible minimum. A product with opacity significantly less than 88 may be considered unsuitable for newsprint, and a product giving a value in excess of 90 is unnecessarily good. The data from the Bureau of Standards report are given at top of next page.

Product	Opacity	Thickness	Ash
Commercial newsprint (3)	90	0.0034–0.0037	0.25
Proprietary products:			
De La Roza Corp.	92	0.0032	13.2
H. L. Horn	82	0.0041	14.9
Chemical Corp.	81	0.0033	18.4
Valite Corp.	78	0.0029	5.4

The De La Roza product is the only one which is acceptable with respect to opacity. It is a premium product in this respect. Opacity could be reduced in one of three ways or by a combination: by decreasing thickness and thus weight, by decreasing the ash content; by decreasing the amount of the expensive titanium dioxide used in the furnish. The characteristics of the paper are such that a considerable latitude for modification is present, making some cost reductions possible.

Opacity of the H. L. Horn paper is undesirably low. There is little to be done about it as the ash content is high as well as thickness. With a weight of 42.8 pounds, 30 percent greater than standard newsprint, there is little or no latitude for improving opacity.

The paper made by the chemical process is low in opacity. Paper thickness is close to ideal but the ash content is extremely high.

The Valite product is lowest in opacity. As ash and thickness are also low, improvement in opacity by changes in the furnish should present no great problems. It is believed that opacity of this paper can be markedly improved.

3. *Printability.*—There are several factors which define more or less clearly the ability of a paper to print. Among them are the ability of a paper to take ink uniformly and quickly, the ability of the ink to be absorbed by the paper without "striking through" to the opposite side, the ability of the ink to make a clear impression of the type without "fuzziness" of outline. Adjustments of inks can be made so that at some speed of printing acceptable results are possible with many, if not most, papers. Except for trials under commercial conditions, judgments of printability must be made on a comparative basis and the probabilities of commercial success estimated by qualified experts.

In order to appraise the printability of newsprint made from bagasse, several steps were taken:

First, the New York Journal of Commerce, which had had previous printing experience with bagasse newsprint, was requested to submit the results of this experience to the Department of Commerce. The following self-explanatory response was received:

THE JOURNAL OF COMMERCE,
New York, September 11, 1952.

MR. JESSE J. FRIEDMAN,
The Department of Commerce,
Washington, D. C.

DEAR MR. FRIEDMAN: We have used the bagasse paper twice in our regular editions of the New York Journal of Commerce and find it to be very good paper. It has more tensile strength with less chance of paper breaks than the ordinary newsprint.

On our regular newsprint we use a standard newspaper ink with an oil base that sinks immediately into the paper. However, we find that this ink is not suitable to the bagasse paper as this has a hard finish and will cause offset on the proceeding paper as it goes through the press.

To overcome this a new type of ink would have to be made up which may cause trouble if it is not properly mixed. You cannot put any drier in this ink because

it will dry on the rollers overnight, and it would be too expensive and practically impossible to wash the rollers on these large newspaper units.

There are some presses that use the ink fountain with pumps that spread the ink on the rollers for distribution. Therefore, the ink that will have to be used on this paper would have to have enough flow so that you could spread it. We find that this is the only drawback as far as newspapers are concerned, and this can be very easily remedied by any standard ink company.

The reproduction of halftone cuts is excellent and all type shows up very clearly.

Hoping that this answers all of your queries, I am,

Sincerely yours,

E. D. MANNING,
Production Manager.

Second, all newsprint samples made at the Bureau of Standards were submitted (without identification as to the process by which made) to the Government Printing Office for thorough printing tests, and a complete report obtained. Copies of all samples as test-printed by the Government Printing Office have been submitted to the subcommittee.

The findings of the Government Printing Office are reprinted below in full. The main conclusions are as follows:

Our tests show that sample B (0002) is suited for newsprint purposes with standard news ink, but even better results have been obtained with ink which is heavier than the standard news ink. Because of the low opacity of the other six samples, they are unsuitable for printing newspapers.

Sample B (0002) submitted to the Government Printing Office was a sample of newsprint made by the De La Roza process.

The Government Printing Office also reported as follows:

The printing tests were performed by means of a Vandercook No. 4 proof press. The rate of printing with this proof press is estimated to be equivalent to about 600 feet per minute for a commercial newsprint installation. We believe that equally good printing results will also be obtained at a press speed of 1,000 feet per minute.

In reviewing the results reported by the Government Printing Office, the following key must be used to identify the various newsprint samples to which reference is made.

A (0001)	Standard newsprint.
B (0002)	De la Roza paper.
C (0003)	Valite paper.
D (0004)	Chemcel paper.
E (0005)	H. L. Horn paper.
F (0006)	Whole bagasse paper (control).
G (0007)	Depithed bagasse paper (control).
H (0008)	Loblolly pine paper (control).

The principal results are summarized below for convenience:

	Index of blackness of print		Index of show-through (penetration)	
	Standard news ink	Halftone book ink	Standard news ink	Halftone book ink
Standard newsprint	18	13	86	86
Proprietary newsprints:				
De la Roza	24	17	89	89
Valite	25	15	76	76
Chemcel	33	20	82	81
H. L. Horn	30	19	82	81
Control newsprints:				
Whole bagasse	31	21	78	77
Depithed bagasse	27	17	83	83
Loblolly pine	27	19	60	57

The De La Roza paper not only is nearly as good as standard newsprint respecting blackness, but it is somewhat superior in the show-through factor. The Valite paper is comparable to newsprint in blackness, but the show-through is so great as to make this product of little if any value for newsprint. The papers made by the Chemcel process and H. L. Horn are superior to the Valite product in show-through but inferior in blackness. In this test the De La Roza paper alone fulfills requirements for satisfactory printability.

Finally, to obtain first-hand experience in the printing results to be obtained, a number of copies of a random 16-page issue of the Congressional Record were printed by the Government Printing Office on a roll of bagasse newsprint made by the National Bureau of Standards. For this purpose, newsprint made by the De La Roza process was selected, primarily because of its satisfactory opacity. The run was made on a pony flat-bed cylinder press, size 21 by 32 inches, on a sheet 17 by 23 inches. The packing of the impression cylinder was medium soft without the rubber blanket normally used on the rotary-press production of the Record. Pages were printed 4-up and backed immediately. Flat-bed book ink was used. Printing was from type without make-ready.

The short run was hand-folded immediately after the press run and trimmed about 1 hour after print. With the size of the paper roll that was supplied, it was not possible to duplicate the normal method of producing the Record on high-speed rotary equipment.

Sample copies of this print of the Record have been submitted to the subcommittee.

UNITED STATES GOVERNMENT PRINTING OFFICE,
Washington 25, D. C., September 19, 1952.

Mr. JESSE J. FRIEDMAN,
Department of Commerce, Washington, D. C.

DEAR MR. FRIEDMAN: Reference is made to our recent telephone conversation and, in reply to letter dated September 16, 1952, from the Honorable Emanuel Celler, chairman of Subcommittee No. 5, Antitrust Subcommittee of Committee on the Judiciary, United States House of Representatives, we are pleased to enclose a laboratory report by Mr. R. H. Simmons, chemist of this Office, on the laboratory tests for evaluating the printing qualities of eight samples of paper submitted, seven of which were made from 100 percent bagasse fibers.

This report is self-explanatory and we trust that it will be of assistance to you in your study covering the utilization of new materials for manufacturing newsprint.

Very truly yours,

JOHN J. DEVINY,
Public Printer.

By M. S. KANTROWITZ,
Technical Director.

SEPTEMBER 19, 1952.

To: M. S. Kantrowitz, Technical Director.
From: R. H. Simmons, Chemist.
Subject: Tests for Evaluating Printing Quality of Samples of Paper Submitted by the Department of Commerce.

Reference is made to a telephone request from Mr. Jesse J. Friedman, of the Department of Commerce, and letter dated September 16, 1952, from the Honorable Emanuel Celler, chairman of Subcommittee No. 5, Antitrust Subcommittee of the Committee on the Judiciary, United States House of Representatives, for performing tests for evaluating the printability of several samples of paper

manufactured from bagasse fibers for comparison with the printing quality of standard newsprint.

Eight samples were submitted, marked "A" to "H," inclusive, which were renumbered by this Office for convenience of identification, from "0001" to "0008", inclusive. Samples marked "A", our designation "0001", is standard newsprint conforming with Government specifications for newsprint in accordance with tests made by the Government Printing Office. The remaining seven samples were all made from 100-percent bagasse fibers.

I am pleased to submit the results of our laboratory tests together with our interpretation and a brief description of the tests performed.

Our tests show that sample "B" (0002) is suited for newsprint purposes with standard news ink, but even better results have been obtained with ink which is heavier in body than the standard news ink. Because of the low opacity of the other six samples, they are unsuitable for printing newspapers. It may be readily observed from the prints of these samples that the printing shows through on the reverse side of the sheet which would interfere with the legibility of any printed matter which might be placed on that side of the sheet.

The measurements for intensity of blackness of print and show-through are the tests by means of which the printability of the samples were numerically evaluated.

We have employed numbers to designate the various paper samples and different inks used in our tests.

1. The number in the lower right-hand corner relates to the paper sample such as 0001, 0002, etc.

2. The numbers on the bottom margin refer to inks used in the printing tests.

(*a*) 0010 is standard news ink obtained from the Washington Evening Star.

(*b*) 0020 is halftone book ink manufactured by the United States Government Printing Office.

(*c*) 0030 is rubber plate black ink made by the United States Government Printing Office.

(*d*) 0040 is identical with 0020 except that 50 percent more ink was used on the press during the performance of the printing tests.

Inks were used in standard amounts, that is, the minimum required to give suitable printing on newsprint, the exception being in series 0040.

The printing tests were performed by means of a Vandercook No. 4 proof press. The rate of printing with this proof press is estimated to be equivalent to about 600 feet per minute for a commercial newsprint installation. We believe that equally good printing results will also be obtained at a press speed of 1,000 feet per minute.

Table I gives the numerical values of the intensity or blackness of the ink in the print. The printed sheets are submitted for your examination and comparison. A low value for color signifies a denser or a print of greater intensity of blackness.

Table II gives the numerical values for show-through. A high value for show-through means that less show-through is visible on the unprinted side of the paper. The measuring instrument for show-through is a photoelectric cell which measures reflectance where 100 percent signifies a full white surface and 0 a full black surface.

Generally, we found that sample 0002 compares favorably with standard newsprint in printability.

TABLE I.—*Blackness of print*

Ink	Paper							
	A (0001)	B (0002)	C (0003)	D (0004)	E (0005)	F (0006)	G (0007)	H (0008)
0010	18	24	25	33	30	31	27	27
0020	13	17	15	20	19	21	17	19
0030	12	17	20	24	23	22	18	21
0040	11	12	12	15	15	15	12	16

TABLE II—*Show-through (ink penetration)*

Inks used	Paper							
	A (0001)	B (0002)	C (0003)	D (0004)	E (0005)	F (0006)	G (0007)	H (0008)
0010	86	89	76	82	82	78	83	60
0020	86	89	76	81	81	77	83	57
0030	83	86	73	80	83	76	69	55
0040	85	86	71	80	81	75	68	53

Key to Inks Used

0010, Standard news ink (Washington Evening Star.)
0020, Halftone book ink (U. S. Government Printing Office.)
0030, Rubber plate black ink (U. S. Government Printing Office.)
0040, Halftone book black, 50 percent extra ink used.

PLIABILITY

One of the most difficult evaluations which had to be made relates to the complex of physical characteristics generally described as pliability of newsprint. Included in the range of this concept are such attributes as softness, flexibility, rattle, tinniness, boardiness, ease of folding, compressibility, and resistance to deformation.

Since there is no adequate laboratory means of measuring this complex of physical qualities realiably, it was determined to obtain the subjective judgments of a representative group of experts qualified to appraise the quality of newsprint from the consumer's standpoint.

Accordingly, a panel of representatives of the following newspaper publishing organizations was convened.

1. Chronicle-Herald, Augusta, Ga.
2. Hearst Newspapers
3. Courier-Journal, Louisville, Ky.
4. Sun, Baltimore, Md.
5. News, Newark, N. J.
6. Herald, Miami, Fla.
7. Times-Herald, Washington, D. C.
8. Inquirer, Philadelphia, Pa.
9. Record-Observer, Centerville, Md.
10. Herald Tribune, New York

This jury was asked to rate each sample of newsprint as "acceptable," "marginal," "unacceptable," or "inconclusive." Samples of standard newsprint were included for purpose of comparison. Samples were identified only by code.

In order to provide a basis for judging the validity of the results, the newspaper representatives were asked to rate each sample as to opacity and printability, as well as pliability. The actual opacity of each sample had been determined on the basis of careful physical tests. The departure of the actual ratings from the known opacity of each paper thus provided a guide as to the basis of the subjective measurement. It was found that a fairly high degree of reliability obtained when "marginal" ratings were included with "acceptable" ratings. Accordingly, this method of scoring was used in computing ratings for pliability. It was the general opinion of the representatives that printability was not susceptible of reliable subjective judgment. Since this was confirmed by erratic results obtained, printability ratings were not used in scoring.

The results as to pliability, using marginal and acceptable ratings as a percentage of total ratings in each case, are as follows:

	Pliability (percent)
Standard newsprints	96
Bagasse and pine papers:	
Depithed bagasse	85
Chemcel	80
Whole bagasse	70
Loblolly pine	70
De La Roza	65
Valite	50
H. L. Horn	30

In the newspaper jury's rating of newsprint as to pliability, the Chemcel paper was considered acceptable or approximately so by 4 out of every 5 votes cast; the De La Roza paper by 2 of every 3 votes cast; the Valite by 50 percent of the votes cast, and the Horn paper by 30 percent of the votes cast.

No unusual reliability is claimed for the approach used in this case. It was intended to provide some means of unbiased indication as to the judgments of newsprint consumers in appraising a characteristic of newsprint which so far defies objective measurement.

RESULTS OF TRIALS: PULP

Analyses and observations were made at the National Bureau of Standards for chemical composition and microscopy of all pulps. The object was to contribute to the general technical knowledge so far as a limited number of tests would permit, and to establish such technical information as would in some part contribute to the improvement of bagasse pulps. Data are presented in tables 4 and 5 of the Bureau of Standards report.

A detailed discussion of these results is inappropriate in this report. However, the staff of the National Bureau of Standards is prepared to point out the significance of the analyses to those interested.

Several statements relating to the nature of bagasse pulps are commonly repeated. Among such assertions are these:

1. Pentosans should be extracted from the raw pulp.
2. The presence of pith is undesirable in a pulp if a pliable paper suitable for newsprint is to result.

The limited data of these tests do not sustain these opinions. The pulp made bythe Valite process showed least pentosans, recovery of pulp was least, and the paper which resulted was not among the best. All other products, except that of the De La Roza process, showed an increase in pentosan content and none of these products was exceptional for use as newsprint. The De La Roza product reduced the pentosan content by half and the resulting paper was, generally, exceptional for use as newsprint. While pentosan content may be a factor in determining the quality of paper, the evidence of the tests made at the Paper Section do not appear to demonstrate the mechanism or correlation.

Presence of pith in the pulp is generally regarded as undesirable if the product is to be newsprint. The data shown in table 5 do not support such a conclusion. The greatest ratios of fiber (mechanical tissue) to pith in the pulps are exhibited by loblolly pine and depithed bagasse. These ratios are 4.0 and 3.8, respectively. The papers which resulted were not exceptional for use as newsprint. Pulps

from whole bagasse (standard kraft cook) and the De La Roza process gave ratios of 2.5 and 2.2 for fiber to pith. The paper made from the former is decidedy inferior for use as newsprint. while the latter is best. Finally, the pulps made by the Valite, Chemcel, and H. L. Horn processes exhibit the lowest fiber to pith ratios, 1.3 to 1.6. The papers made from these pulps are in no wise exceptional.

It would appear that neither pentosans nor pith alone, nor in combination, are sufficient to define the characteristics of papers made at the Paper Section.

Recovery data and operating conditions are presented in table 2 of the Bureau of Standards report. Recoveries in all cases are based upon 100 pounds of oven dry raw materials, bagasse, and loblolly pine. The bagasse as received from Louisiana, less moisture, represents the basis for all evaluations.

Attention is directed to the fact that recovery of pulp from loblolly pine was only 41.4 percent of the charge. Normal commercial practice permits yields of 45 to 48 percent. This suggests that in order to correct results to commercial attainability, yields of all tests made at the Paper Section should be increased by about 12 percent. No such correction was applied in results shown in table 2 in spite of the fact that several of the proprietors of processes claimed that the yields obtained were lower than their experience showed to be typical. The recovery of pulps as actually obtained and as increased by about 12 percent are summarized below:

Pulp recovery

Process	Percent of raw oven-dry bagasse	
	Actual	Corrected for pilot losses
Proprietary processes:		
De La Roza	44.6	50.2
Valite	34.7	39.0
Chemcel	45.4	51.1
H. L. Horn	48.4	54.4
Control processes:		
Whole bagasse	58.9	66.3
Depithed bagasse	27.9	31.4
Loblolly pine	41.4	46.5

The Valite process gives the lowest recoveries among the proprietaries. The others vary from 44.6 to 48.4 percent. It is doubtful whether variations in this range are interpretable. On a commercial scale of operation, recoveries by the De La Roza, Chemcel, and H. L. Horn processes would approximate 50 percent of the weight of raw bagasse.

ECONOMIC CONSIDERATIONS

The conclusions suggested by the technical investigation discussed in the preceding section are as follows:

1. Of the newsprints manufactured by various processes at the National Bureau of Standards, only one was considered satisfactory in all significant respects for newspaper use. This was the newsprint

made by the De La Roza process. Other processes also show potentialities for successful development although the papers actually made by these processes in these specific trials were found to be unsatisfactory in one or more respects.

2. While the technological feasibility of successfully manufacturing satisfactory newsprint from whole bagasse has been established on a pilot scale, production feasibility on a commercial scale remains to be demonstrated.

3. To determine the economic practicability of using bagasse as a newsprint material, commercial production in a suitable paper mill and commercial printing runs on a standard newspaper press should be made.

In reviewing the commercial possibilities of bagasse as a raw material for newsprint, other economic factors must also be taken into account. The more important of these are as follows:

1. Costs of obtaining raw bagasse.
2. Quantity of bagasse required to make a ton of finished newsprint.
3. Chemical requirements and costs for processing bagasse to provide a suitable pulp and newsprint.
4. Indications as to over-all production costs to make newsprint from bagasse in comparison with those for standard newsprint.
5. Availability of bagasse in the United States and elsewhere.

Perhaps the most authoritative survey which has been made concerning current costs of sugarcane bagasse available in the United States has been that conducted in Louisiana by Prof. Arthur G. Keller, of Louisiana State University. The report of this survey, which was based in large measure on actual procurement experience by the major purchaser of Louisiana bagasse at the present time, is reprinted in full in the appendix. Estimated costs per ton of bone-dry fiber, as reported in this survey, are as follows:

Purchase price of bagasse, including fuel value and slight bonus	$2.50
Baling, stacking, and covering bagasse in the field	6.00
Loading costs, storage to railroad cars	.50
Total cost, f. o. b. cars	9.00

Freight rates are estimated at $1.25 per ton of bone-dry fiber per 100 miles by rail, and about $1 per ton per 100 miles by barge. From the data cited in this report, the probable delivered cost of bagasse for mills located reasonably close to sources of supply would range from $10 to $12 per ton of fiber.

The amounts of bone-dry bagasse required to make 1 ton of pulp and the amount of pulp actually used in paper vary with the process used. The results obtained at the National Bureau of Standards are presented in tables A and B. In the De La Roza process, requirements were 2.24 tons of bone-dry bagasse to produce 1 ton of pulp, and 1.9 tons of bagasse to yield 1 ton of newsprint. The probable cost of bagasse thus ranges from $19 to $22.80 to make 1 ton of finished newsprint by this process.

Items of cost relating to chemicals include requirements for (1) prehydrolysis and digestion; (2) chlorination and bleach; and (3) furnish other than pulp.

Estimates of amounts and costs of chemicals consumed in all processes tested at the National Bureau of Standards are shown in tables

A and B. In computing chemical consumption, recovery rates based upon common experience in the industry were used. Estimated current average delivered prices were used in translating these quantities into estimated costs. Based upon these calculations, the costs of chemicals required to make 1 ton of newsprint by the De La Roza process are estimated as follows:

Pulping	$3.00
Bleach	2.90
Furnish other than pulp	7.35
Total	13.25

TABLE A.—*Materials requirements to make 1 ton of newsprint (o. d.)*

[Data derived from table 2]

	Proprietary bagasse newsprint				Control newsprint		
					Bagasse		
	De La Roza	Valite	Chemcel	H. L. Horn	Whole	Depithed N. R. R. L.	Loblolly pine
Whole bagasse, as received tons	2.03	2.66	1.84	1.80	1.61	3.34	2.32
Digester:							
Sodium hydroxide pounds	816	601	294	359	309	404	1,067
Other, as Na_2O do	207	37	121	388	191	316	269
Chlorination and bleach:							
Chlorine pounds		216	195	100	63.5	197	101
Calcium hypochlorite pounds	171	192	143	126	132	64	27
Sodium hydroxide pounds	19	67	63	64	51	61	71
Furnish:							
Clay do	207	98.4	33.4	261	100	102	93
Titanium dioxide do	41.4	9.6	16.5	17.2	28.7	30.3	28.8
Rosin and alum do	32.5	60.1	30.5	10.8	11.3	23.6	16.2
Yield of paper (o. d.) ton	1	1	1	1	1	1	1

TABLE B.—*Estimation of chemicals costs* [1]

[Unit: dollars per ton paper (o.d.)]

	De la Roza	Valite	Chemcel	H. L. Horn	Bagasse		Loblolly pine
					Whole	Depithed	
Prehydrolysis and digestion	2.90–3.10	0.65–0.70	1.45–1.55	2.15–2.30	2.25–2.40	2.95–3.10	4.05–4.35
Chlorination and bleach	2.85–2.95	6.30–6.90	9.20–10.20	5.90–6.35	4.80–5.00	5.35–5.50	3.50–3.70
Furnish (other than pulp)	7.15–7.55	4.40–4.60	4.40–4.55	4.25–4.35	4.30–4.45	4.05–4.15	4.30–4.60
Total, range	12.90–13.60	11.35–12.20	15.05–16.30	12.30–13.00	11.35–11.85	12.35–12.75	[2] 11.85–12.65

[1] Basis of an integrated plant where raw materials costs are—

Salt cake	per ton delivered	$23.57
Limestone	do	$3.87
Soda ash	do	$30.50
Chlorine	do	$64.50
Clay	do	$15.00
Rosin	cents per pound delivered	7
Titanium dioxide	cents per pound delivered	21

[2] Titanium dioxide costs assigned were $2.80 to $3.10 per ton giving a range around $9 a ton for chemicals and furnish less titanium dioxide.

TABLE C.—*Approximate range of production costs per ton of newsprint; comparisons of selected major variables only*

Item	Unit	Standard newsprint		Bagasse newsprint
		Groundwood portion	Chemical portion	
Raw material:				
Wood:				
Quantity required per ton of newsprint	Cords	1.1	2.0	
Cost per cord (delivered, peeled, ready for processing)	Dollars	20–30	20–30	
Cost per ton of newsprint	do	22–33	40–60	
Bagasse:				
Quantity required per ton of newsprint	Tons			1.9
Cost per ton (delivered, ready for processing)	Dollars			10–12
Cost per ton of newsprint	do			19–22.80
Electric power:				
Groundwood:				
Energy required per ton of pulp	Kilowatt hour	1,200–1,300		
Cost per kilowatt-hour	Mills	3.5–7.5		
Cost of energy per ton of pulp	Dollars	4.20–9.75		
Chemical and bagasse, cost per ton of pulp	do		.50	.50
Steam, cost per ton of pulp	do		2.50–3.50	2.50–3.50
Chemicals:				
Pulping, cost per ton of newsprint	do		5.00	3.00
Bleach, cost per ton of newsprint	do		4.00	2.90
Furnish, cost per ton of newsprint	do	1.50	1.50	7.35
Total of selected variable costs:				
Indicated range	do	27.70–44.25	49.50–74.50	35.25–40.05
Weighted range (80 percent groundwood—20 percent chemical)	do	32.10–50.30		
Indicated average		41.20		37.65

NOTE.—Above costs are for selected major variables only, and do not include such other costs as finishing, labor, and overhead.

In order to obtain a rough approximation of the production costs for newsprint made from bagasse as compared with those for standard newsprint, major variable costs were selected for examination. These costs include raw material, chemicals, steam, and power.

The approximate range of these variable costs in newsprint production, as suggested by the most reliable data obtainable, is shown in table C.

Wood costs are based upon average experience in various areas of the country. Chemical costs are based upon Bureau of Standards tests in the case of bagasse and upon estimates of industry technicians in the case of wood pulps. Steam costs are also used as estimated by industry technicians. Costs of electric power are estimated in the range of 3½ to 7½ mills, representing a reasonable range for the country as a whole.

The figures in table C are not intended to convey precise comparisons of cost calculations but, rather, to suggest the likely range of such comparisons for working purposes. In appraising these figures, the following considerations need also to be taken into account:

1. Subject to the qualifications mentioned earlier concerning a demonstration as to the maximum speeds at which bagasse newsprint can be commercially run, manufacturing costs for processing pulps into newsprint are estimated to be approximately the same for bagasse as for standard newsprint.

2. The difference shown in the table between total selected variable costs for bagasse newsprint and those for standard newsprint reflects in part the use of filler in the bagasse product. Little if any filler is used in most standard newsprint. If allow-

ance were to be made for use of increased filler, costs in comparison with bagasse newsprint would be correspondingly lower.

3. Some producers may be able to obtain wood from their own timberlands at somewhat lower costs than indicated. On the other hand, costs of acquiring and maintaining such timberlands are not applicable to bagasse.

4. Bagasse requirements per ton of newsprint are based upon actual pilot experience at the National Bureau of Standards. It is common experience that pulp and paper yields per ton of raw material is greater, although variably so, in commercial equipment than in smaller-scale equipment. This was noted in control tests made on loblolly pine for which a lower recovery was obtained at the National Bureau of Standards than normal commercial experience would indicate. No allowance was made for this difference in approximating costs.

5. Estimated chemical costs for bagasse represent an upper limit, particularly with respect to the quantity of titanium dioxide required. This expensive material is used as an opacifier. Somewhat smaller quantities could be used without reducing opacity below the minimum required for newspaper use.

6. Labor and overhead costs for bagasse pulp are estimated to be somewhat higher than for groundwood pulps, although this is offset in some measure by wood handling and processing costs not applicable to bagasse.

Again, precision is neither claimed nor possible for the various costs shown in the table. Such approximations as are possible at this time, however, on the basis of available data, suggest that costs of manufacturing newsprint from bagasse may be considered as generally in line with estimated costs for standard newsprint.

The United States normally produces close to 900,000 tons of sugarcane bagasse annually as a byproduct of sugarcane production. About four-fifths of this supply is concentrated in Louisiana, with virtually all of the remainder produced in Florida. Of the total, about 200,000 tons is now used for the production of wallboard. The balance, for the most part, is burned as fuel by the sugar mills; in a number of areas where bagasse production is in excess of fuel requirements, mill furnaces are operated at relatively low efficiency, or resort is made to outdoor burning to dispose of the surplus.

It is estimated that on an annual basis sufficient bagasse would be available in the United States to provide the raw-material requirements of two mills of economic size manufacturing newsprint from bagasse. While cane-sugar production in the United States is a seasonal operation varying in length from 2½ months in Louisiana to 6 months in Florida, storage presents no insurmountable technical or economic problems. The technology of proper treatment is well known, and qualified engineering authorities have reported that when properly baled and stacked bagasse can be kept for several years without serious loss.

A thorough study of supply concentration of bagasse in Louisiana, together with a review of treatment, baling, and storage considerations, is contained in the report by Prof. A. G. Keller of Louisiana State University, which is referred to above and is reprinted in the appendix.

Compared to many other areas of the world the United States is a relatively small producer of sugarcane. World supply availabilities

of bagasse are estimated at approximately 25 million tons annually, as reported by the Mutual Security Administration. Estimated world production of bagasse in 1950 and 1951, based upon centrifugal sugar production, which is considered a conservative basis of calculation, is contained in table D.

It will be noted from this table that three to four times the quantity of bagasse produced in the United States is available annually in the Territories of Hawaii and Puerto Rico, while in Cuba and other countries of the Carribean area about 10 million tons of bagasse a year are produced. Approximately half of the world supply is located in South America, the Far East, and Africa. To a large extent, sugarcane grows in areas which now import their newsprint over the greatest distances. The mere availability of the raw material in any country is not sufficient to assure that it can be economically used in the manufacture of newsprint or other papers. Costs of substitute fuels and other local conditions must be considered in each case.

Special studies prepared for this report on bagasse supply and cost considerations in Hawaii and in Cuba, together with a recent review of the potentialities of bagasse in relation to the newsprint problem in India, are contained in the appendix to this report.

It is encouraging to note that Crown-Zellerbach, the major west-coast newsprint producer in the United States, is engaging in a cooperative undertaking with the Hawaiian Sugar Planters' Association to investigate, in its new pilot paper mill at Camas, Wash., the potentialities of bagasse as a raw material for pulp manufacture.

TABLE D.—*World availability of sugarcane bagasse for all purposes (bone dry basis—Estimated on the basis of centrifugal cane sugar production)*

[Short tons]

Continent and country	1950	1951
United States and Territories:		
Louisiana	750,000	500,000
Florida	125,000	115,000
Hawaii	1,000,000	1,100,000
Puerto Rico	1,300,000	1,400,000
Virgin Islands of the United States	7,000	12,000
Total United States and Territories	3,182,000	3,127,000
Other North American and Central American countries:		
British Honduras	2,000	3,000
Costa Rica	24,000	24,000
El Salvador	21,000	31,000
Guatemala	29,000	33,000
Honduras	5,000	7,000
Mexico	800,000	850,000
Nicaragua	30,000	32,000
Panama	19,000	22,000
Antigua	21,000	36,000
Barbados	184,000	170,000
Cuba	6,500,000	8,000,000
Dominican Republic	600,000	700,000
Granada	1,000	1,000
Guadeloupe	85,000	95,000
Haiti	65,000	65,000
Jamaica	300,000	315,000
Martinique	60,000	50,000
St. Kitts	50,000	50,000
St. Lucia and St. Vincent	14,000	14,000
Trinidad	160,000	170,000
Subtotal	8,970,000	10,668,000
Total North and Central American countries, including United States and Territories	12,152,000	13,795,000

TABLE D.—*World availability of sugar cane bagasse for all purposes (bone dry basis—Estimated on the basis of centrifugal cane sugar production)*—Continued

[Short tons]

Continent and country	1950	1951
Asia and Far East:		
Burma	5,000	16,000
China (mainland)	400,000	400,000
Formosa	410,000	620,000
French Indochina	7,000	6,000
India	1,500,000	1,600,000
Indonesia	310,000	480,000
Pakistan	60,000	100,000
Philippines	950,000	1,100,000
Thailand	35,000	35,000
Total Asia	3,677,000	4,357,000
South America:		
Argentina	720,000	760,000
Bolivia	3,000	3,000
Brazil	1,800,000	1,900,000
British Guiana	250,000	260,000
Colombia	220,000	250,000
Ecuador	61,000	60,000
Paraguay	26,000	33,000
Peru	525,000	525,000
Surinam	4,000	4,000
Uruguay	8,000	14,000
Venezuela	53,000	55,000
Total South America	3,670,000	3,864,000
Africa:		
Belgian Congo	15,000	17,000
British East Africa	90,000	90,000
Egypt	215,000	220,000
Madagascar	15,000	20,000
Madeira Islands and Azores	10,000	10,000
Mauritius	510,000	540,000
Mozambique	105,000	105,000
Angola	60,000	55,000
Reunion	120,000	140,000
Unión of South Africa	700,000	550,000
Total, Africa	1,840,000	1,747,000
Oceania:		
Australia	1,100,000	900,000
Fiji	135,000	130,000
Total, Oceania	1,235,000	1,030,000
World total	22,574,000	24,793,000

Source: Mutual Security Administration.

NATIONAL BUREAU OF STANDARDS REPORT NO. 1869 ON INVESTIGATION OF BAGASSE FOR NEWSPRINT TO OFFICE OF INDUSTRY AND COMMERCE, UNITED STATED DEPARTMENT OF COMMERCE

An investigation of the use of bagasse fiber (sugarcane residue) was made at the National Bureau of Standards in accordance with plans outlined at a meeting of representatives of the Office of Industry and Commerce, the National Bureau of Standards, and other agencies at the Department of Commerce Building on June 4, 1952, and supplemented by oral and written instructions received later by the Bureau.

Papers were made in the paper mill at the Bureau, using four processes made known by their proprietors. These were:

de la Roza Corp., New York, N. Y.
Representative: Mr. Joaquin de la Roza, Sr.
Valite Corp., New Orleans, La.
Representative: Mr. W. J. Amoss.
H. L. Horn, New York, N. Y.
Representative: Mr. Harry L. Horn.
Kinsley Chemical Co. (Chemcel process), Cleveland, Ohio.
Representative: Mr. Thomas Yetman.

The details of these processes are given in table 2. The bagasse fiber used was taken from a 1-ton lot furnished by the New Iberia Sugar Cooperative, New Iberia, La.

Paper was also made from the whole bagasse, as received, using a Kraft digestion process based on recommendations received from the Northern Regional Research Laboratory, Peoria, Ill. This process involved only methods and materials well known to the industry. The Northern Regional Research Laboratory does not endorse it as a practicable process, however.

Another lot of paper was made by the same well-known Kraft process using a lot of bagasse fiber depithed by the Northern Regional Research Laboratory. This process is identified in part by the initials N. R. R. L., but the same limitation as to that laboratory's endorsement is applicable.

In order to establish a criterion for comparison of the engineering data on these processes with a process using materials familiar to the pulp and paper industry, a lot of paper was made from loblolly pine chips supplied by P. H. Glatfelter & Co. A standard sulfate digestion was used for this process. Details were based on recommendations from the Forest Products Laboratory, Madison, Wis.

Quantities of all materials used and yields at the various stages of the processes were recorded. These are also given in table 2.

Physical tests and chemical analyses of the papers were made, and are given in tables 1 and 4, respectively.

Table 3 shows the calculated quantities of materials required to make 1 ton of newsprint. The calculations were made from the operating data in table 2.

Since the effect and treatment of pith cells are generally considered of major importance in the making of paper from bagasse, a study was made of the incidence of fiber and pith in the bleached pulps produced by the various processes. The results are given in table 5.

For the purposes of comparison, physical tests were also made on samples of newsprint obtained from the Washington Post, the Washington Star, and the New York Times. These data are also given in table 1.

Samples of the papers produced have been submitted to the Office of Industry and Commerce.

All tests and analyses were made by standard methods of the Technical Association of the Pulp and Paper Industry, where applicable.

Participating investigators were: P. Abendschein, J. J. Erving, M. N. Geib, J. L. Harvey, R. B. Hobbs, W. Hubbard, J. K. Missimer, J. Moynihan, M. J. O'Leary, H. F. Riddell, E. B. Randall, S. Wasik, W. K. Wilson, and T. L. Worksman.

For the Director by:

ROBERT B. HOBBS,
Acting Chief, Paper Section,
Division of Organic and Fibrous Materials.

Enclosures.

TABLE 1.—*Paper for newsprint: Physical analyses*

	Standard newsprint [1]			Proprietary bagasse newsprint [3]				Control newsprints [3]		
								Bagasse		Loblolly pine
	No. 1 (New York Times)	No. 2 (Washington Post)	No. 3 (Washington Star) (Spruce Mills)	De la Roza	Valite	Chemcel	H. L. Horn	Whole	Depithed NRRL [2]	
Weight:										
25 by 40 inches, 500 sheets, pounds	38.5	38.9	37.6	41.4	38.4	41.5	49.5	37.2	34.0	31.5
24 by 36 inches, 500 sheets, pounds	33.3	33.6	32.5	35.8	33.4	35.9	42.8	32.1	29.3	27.2
Thickness, inch	.0037	.0034	.0035	.0032	.0029	.0033	.0041	.0031	.0031	.0031
Bursting strength, points	7.0	7.0	7.0	11.0	8.0	10.0	13.5	13.0	10.5	12.0
Folding endurance, double folds:										
Machine direction	4.0	4.0	5.0	13	7	9.0	12	45	9	44
Cross direction	1.0	1.0	1.0	7	5	9.0	11	18	6	14
Tensile strength per 15 millimeters (Schopper):										
Machine direction	2.4	2.2	2.4	3.9	3.0	3.0	4.1	3.7	2.7	2.7
Cross direction	1.3	1.2	1.2	2.1	1.8	2.0	3.0	2.6	2.3	1.5
Tearing strength (Elmendorf):										
Machine direction	19	19	19	29	19	23	25	23	22	42
Cross direction	22	23	23	43	18	22	24	25	22	66
Smoothness, sec. (Bekk)	60	65	60	15	15	7.0	5.5	7.0	15	10
Ash, oven-dry basis	.25	.25	.24	13.2	5.4	18.4	14.9	8.0	6.5	4.2
Opacity, contrast ratio, dry, percent	90	90	90	92	78	81	82	79	78	73
Fiber composition, percent:										
Chemical wood	20	20	30							100
Bagasse				100	100	100	100	100	100	

[1] Standard newsprint: random unprinted samples obtained from publishers.
[2] NRRL: Northern Regional Research Laboratory, Peoria, Ill.
[3] Proprietary and control newsprints: pulp and paper made at the Paper Section, National Bureau of Standards.

TABLE 2.—*Operating conditions and materials*

[Units: Pounds per 100 pounds (oven dry) of whole bagasse]

	Proprietary bagasse newsprint				Control newsprints		
					Bagasse		Loblolly pine
	de la Roza	Valite	Chemcel	H. L. Horn	Whole	Depithed (NRRL)	
Bagasse or wood chips, as received, oven-dry basis, pounds	100	100	100	100	100	100	100
Recovery after treatment, pounds:							
Dusted [1]	90	90					
Depithed [2]						62	
Prehydrolysis, conditions:							
Water, pounds			None	None	None	None	None
Steam: T.(°F.); hours at T	325; 2.0	320; <1.0 pH 2.0					
Digester:							
Additions:							
Water, pounds	450	520	600	460	360	235	380
Sodium hydroxide, pounds	20.1	11.3	8.0	10.0	9.6	6.0	23.0
Other, including Na_2S; Na_2O equivalent [3]	5.1	0.7	3.3	10.8	6.1	4.7	5.8
Conditions—Steam: T.(°F.); hours at T	306; 2.0	250; 6.0	243; 6.0	240; 1.25	332; 1.5	332; 1.25	330; 2.5
Causticity, percent [4]	75		[6] 67	47.5	55.2	55.2	75.0
Sulfidity, percent [5]	25				44.8	44.8	25.0
Recovery, pounds:							
Fiber	47.4	41.9	49.2	61.0	66.0	30.1	43.8
Na_2O, total equivalent [6]	20.3	9.2	9.2	18.1	13.2	8.2	23.1
Wash, Na_2O loss, pounds	0.40	0.18	0.19	0.37	0.27	0.17	0.47
Chlorination:							
Conditions	[7]	[8]	[8]	[8]	[8]	[8]	[8]
Equipment [10]	[7]	[9]	[8]	[8]	[8]	[8]	[8]
Pulp consistency, percent	[7]	3.0–3.5	3.0	4.0	3.5–4.0	3.25	3.25

[1] Variations in small units are relatively great; a nominal 10 percent loss is taken here as the same equipment was used.
[2] Losses reported by Northern Regional Research Laboratory vary from 35–40 percent, 62 percent is said to be average, or nearly so.
[3] Includes estimated Na_2O equivalence of "K" chemicals; "K" chemical is employed in the Chemcel process and is not revealed here.
[4] NaOH divided by Na_2CO_3, Na_2S and other sodium-containing compounds, all in terms of Na_2O equivalence.
[5] Na_2S divided by NaOH, Na_2S and other sodium-containing chemicals, all in terms of Na_2O equivalence; as all proprietary processes do not use Na_2S, values are not reported in such cases.
[6] Basis of 2.0 percent loss in cooking and washing operations.
[7] Not used.
[8] Closed system.
[9] Open beater.
[10] Closed system modeled after the chlorinator at Herty Foundation Laboratory, Savannah, Ga.

TABLE 2.—*Operating conditions and materials*—Continued

[Units: Pounds per 100 pounds (oven dry) of whole bagasse]

	Proprietary bagasse newsprint				Control newsprints		
					Bagasse		
	de la Roza	Valite	Chemcel	H. L. Horn	Whole	Depithed (NRRL)	Loblolly pine
Chlorination—Continued							
Input, pounds:							
Fiber	(7)	41.9	49.2	61.0	66.0	30.1	43.8
Water	(7)	1,250	1,640	1,220	1,750	926	1,350
Chlorine (free)	(7)	4.06	5.32	2.80	1.97	2.92	2.18
Alkaline extraction; conditions (open beater):							
Pulp consistency	(7)	3.5–4.0	4.0	3.25	3.5–4.0	3.25	3.25
Sodium hydroxide equivalent, pounds	(7)	.84	1.23	1.18	0.92	0.60	1.08
Hypochlorite bleach, conditions (open beater):							
Pulp consistency, percent	3.5–4.0	3.5–4.0	4.0	3.5	3.5–4.0	3.5–4.0	3.25
Calcium hypochlorite, pounds	4.2	3.6	3.9	3.5	4.1	0.93	0.58
NaOH, pounds [11]	0.47	0.42	0.49	0.61	0.66	0.30	0.44
Yield of fiber, pounds	44.6	34.7	45.4	48.4	58.9	27.9	41.4
Freeness, Schopper-Riegler [12]	710	690	495	725	545	770	850
Furnish (fiber as above), pounds:							
Clay	5.10	1.85	9.10	7.26	3.10	1.51	2.00
Titanium dioxide	1.02	0.18	0.45	0.48	0.89	0.45	0.62
Rosin and alum	0.80	1.13	0.83	0.30	0.35	0.35	0.35
Total	51.52	37.86	55.78	56.44	66.50	30.21	44.37
Filler retention, percent	75	96	95	94	77	90	64
Total Na_2O loss, pounds [13]	1.86	0.85	0.85	1.66	1.22	0.77	2.12
Total yield of paper, pounds	49.2	37.6	54.5	55.7	62.0	29.7	43.1

[7] Not used.
[11] An arbitrary allowance of 1 percent NaOH on oven-dried fiber for pH control.
[12] Schopper-Riegler freeness tests on air-dried bleached pulps using 2 g oven-dried fiber per 1 at 30° to 32° C.
[13] An arbitrary over-all loss of 9 percent is taken on all processes and represents make-up requirements.

TABLE 3.—*Materials requirements to make 1 ton of newsprint oven dry*

[Data derived from table 2]

	Proprietary bagasse newsprint				Control newsprints		
					Bagasse		
	de la Roza	Valite	Chemcel	H. L. Horn	Whole	Depithed (NRRL)	Loblolly pine
Bagasse or wood chips, as received, oven-dry basis, tons	2.03	2.66	1.84	1.80	1.61	3.34	2.32
Digester:							
Sodium hydroxide, pounds	816	601	294	359	309	404	1,067
Other, pounds—as Na_2O	207	37	121	388	191	316	269
Chlorination and bleach:							
Chlorine, pounds		216	195	100	63.5	197	101
Calcium hypochlorite, pounds	171	192	143	126	122	64	27
Sodium hydroxide, pounds	19	67	63	64	51	61	71
Furnish:							
Clay, pounds	207	98.4	33.4	261	100	102	93
Titanium dioxide, pounds	41.4	9.6	16.5	17.2	28.7	30.3	28.8
Rosin and alum, pounds	32.5	60.1	30.5	10.8	11.3	23.6	16.2
Yield of paper (oven dry), ton	1.00	1.00	1.00	1.00	1.00	1.00	1.00

TABLE 4.—*Paper for newsprint: Chemical analyses*

[Unit: percent composition by weight [1]]

	Proprietary bagasse newsprint				Control newsprints		
					Bagasse		
	de la Roza	Vaiite	Chemcel	H. L. Horn	Whole [2]	Debithed (NRRL)	Loblolly pine [3]
Raw materials:							
Total cellulose [4]					65	75	66
α-cellulose					33	44	63
β- and γ-celluloses					32	31	3
Lignin					25	21.5	28.6
Pentosans [5]					25.5	26.9	10.3
Ash					4.3	1.4	.2
Extractives [6]					5.9	2.3	5.2
Fiber after bleach:							
Total cellulose [4]	96	96	99	98	[7] 97	[7] 99	[8] 99
α-cellulose	71	83	67	64	66	67	80
β- and γ-celluloses	25	13	32	34	31	32	19
Lingin					0	0	0
Pentosans [5]	12.6	4.6	28.6	30.2	29.3	27.0	10.2
Ash	3.8	4.0	1.2	2.0	3.2	1.0	.7
Paper:							
Ash and inerts [9]	14.0	6.1	21.3	17.2	8.7	7.8	5.2
Ash from fiber only	3.4	3.9	.8	1.7	3.0	.9	.7
Clay and titanium	10.1	1.7	20.1	15.1	5.8	6.4	4.0
Other	.5	.5	.4	.4	.5	.5	.5

[1] All results on moisture-free basis; test methods are those of the Technical Association of the Pulp and Paper Industry.
[2] Raw whole bagasse obtained from New Iberia, La., courtesy of Mr. Leon Landry.
[3] Chips supplied by P. H. Glatfelter Co., Spring Grove, Pa.
[4] Equals 100 percent less (lignin, extractives, and ash); β- and γ-celluloses were not separately determined.
[5] Percent pentosans $= \frac{7.5\,N(V_2 - V_1)}{W} - 1$ (ref. Technical Association of the Pulp and Paper Industry Standard T223m).
[6] Bagasse extracted with boiling water; pine chips with alcohol, alcohol-benzene, and hot water.
[7] Specifications for cook and furnish based on recommendations by Northern Regional Research Laboratory, Peoria, Ill.
[8] Conditions based on recommendations by U. S. Forest Products Laboratory, Madison, Wis.
[9] Ash only determined; this less ash in pulp, less TiO_2 was multiplied by 1.14 and to the product added ash in pulp, TiO^2 and rosin to obtain ash plus retained filler and size.

[b] Ash only determined; this less ash in pulp, less TiO_2 was multiplied by 1.14 and to the product added ash in pulp, TiO^2 and rosin to obtain ash plus retained filler and size.

TABLE 5.—*Incidence of fiber and pith in bleached pulps*

	Fiber pith [1]	Whole pith fragments [2]	Fiber incidence relative [3]	Notes
Proprietary bagasse newsprint:				
De la Roza	2.2	0.8	55	Straight fibers; some aggregation.
Valite	1.3	1.0	33	Aggregation; capricious distribution.
Chemcel	1.6	.8	40	Some tendency to form aggregates.
H. L. Horn	1.5	.8	37	Some aggregation.
Control newsprints:				
Whole bagasse	2.5	5.9	63	Fibers straight; aggregation.
Depithed bagasse, NRRL	3.8	.5	95	No tendency to aggregate; fibers straight.
Loblolly pine	4.0	1.0	100	Do.

[1] Microscopic count; number of mechanical fibers per pith cell.
[2] Microscopic count; number of whole pith cells per fragments equivalent to one pith cell; fragmentation is in great part a function of the character of cook.
[3] Relation of fiber-pith ratios where loblolly pine (4.0) equals 100.

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APPENDIX

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APPENDIX A

MINUTES OF SPECIAL CONFERENCE OF NEWSPRINT MANUFACTURERS, JUNE 18, 1952

Lyall Tracy, Pulp, Paper, and Paperboard Division, NPA, Government presiding officer

INDUSTRY REPRESENTATIVES PRESENT

Charles T. Hicks, Bowater Paper Co., New York, N. Y.
Ray C. Burrus, Columbine Development Co., Grand Junction, Colo.
A. G. Wakeman, Coosa River Newsprint Co., Coosa Pines, Ala.
J. D. Zellerbach, Crown-Zellerbach Corp., San Francisco, Calif.
J. R. Snyder, Gary Paper Co., Gary, Ind.
D. L. Stocker, Michigan Paper Co., Plainwell, Mich.
Florence Lynch, Pacific Paperboard Co., Longview, Wash.
Jack J. Arnold, Paper Corp. of America, New York, N. Y.
Gene Robb, Pejebscot Paper Co., New York, N. Y.
Edward McSweeney, Southland Paper Mills, Inc., Lufkin, Tex.
Kilby Osborn, St. Croix Paper Co., Boston, Mass.
James L. Knight, St. Lawrence Paper Corp., New York, N. Y.
A. Kleinman, Warrensburg Pulp & Paper Co., New York, N. Y.
George F. Russell, West Tacoma Newsprint Co., Steilacoom, Wash.

GOVERNMENT REPRESENTATIVES PRESENT

National Production Authority:
Pulp, Paper, and Paperboard Division:
M. J. Burns
LeRoy V. Hicks
Frederic Mears
T. H. Mullen
A. G. Natwick
Lawrence W. Strattner, Chemical, Rubber, and Forest Products Bureau
Nathaniel Rafler, Office of Industry Advisory Committees
John R. McDonald, Office of Public Information
Edward A. Nichols, Office of General Counsel
Marie Pfeiffer, Office of Small Business
Delores Hendershott, minute writer
Other agencies:
Wallace C. East, Small Defense Plants Administration
Mathias Niewenhouse, Defense Production Administration

PURPOSE OF THE CONFERENCE

Representatives of the newsprint producing industry met in conference on June 18, 1952, to discuss the feasibility of increasing newsprint production in the United States.

Mr. Lyall Tracy (Director, Pulp, Paper, and Paperboard Division, NPA) was the Government presiding officer.

RULES GOVERNING INDUSTRY MEETINGS

Mr. Nathaniel Rafler (Office of Industry Advisory Committees, NPA) welcomed the group and explained that special conferences with industry are called to consider a specific problem which is not likely to require the type of continuous or regular consideration that necessitates the organization of an industry advisory committee. Like industry advisory committee meetings, however, special conferences adhere to certain rules established by the Department of

Justice, Mr. Rafler said. Copies of the Rules Applicable to Meetings with Groups of Industry Representatives, as revised effective January 2, 1952, were distributed.

In selecting representatives to attend the present conference, Mr. Rafler continued, NPA contacted all of the known producers of newsprint in 1950–51 as listed by the Bureau of the Census, as well as three prospective manufacturers. Many of those who were invited declined because their production does not normally include newsprint and they have now discontinued the incidental production which they offered during the period of critical shortage.

Mr. Edward A. Nichols (Office of the General Counsel, NPA) outlined the conditions under which groups of industry representatives may meet without being in violation of the antitrust laws.

INTRODUCTORY REMARKS

Mr. Tracy told the group that the Pulp, Paper, and Paperboard Division, NPA, in connection with its responsibilities under the Defense Production Act is interested in the problem of newsprint production and has been asked to cooperate in preparing material on newsprint production for a Department of Commerce report to the Antitrust Subcommittee of the House Judiciary Committee. The general purpose of the study is to determine whether it is practicable and advisable to expand newsprint production in the United States. Other interested Government agencies will also be consulted, Mr. Tracy added.

FEASIBILITY OF EXPANDING NEWSPRINT PRODUCTION IN THE UNITED STATES

To ascertain the views of representatives from companies which now produce or contemplate producing newsprint in the United States, Mr. Tracy presented a series of questions prepared by the NPA Pulp, Paper, and Paperboard Division. Opinions on questions in the separate areas of (1) competitive and international considerations, (2) economic considerations, and (3) geographic considerations (including raw materials) will later be combined to obtain an over-all viewpoint of the industry, he said.

Competitive and international considerations

The series of questions in this area, Mr. Tracy explained, is intended to determine whether newsprint production should be considered on a national, international, or North American Continent basis. A particularly important consideration, he said, is whether the United States as a Nation should attempt to readjust a balance in newsprint production, which has become predominantly Canadian.

Question: Should newsprint production in the United States be expanded above the present level? Mr. Tracy explained that a newsprint expansion goal of 494,000 tons annually has been approved by the Defense Production Administration.

Industry representatives expressed divergent views on whether production should be expanded beyond the goal already established by DPA. There appeared to be some preponderance of opinion that there should be no specific drive for expansion in the United States beyond the level which would come about naturally as a result of basic economic developments.

Representatives who opposed further expansion pointed out that demand for newsprint has recently slackened considerably. One representative remarked that the shortage had been an artificial one, created by those publishers who overcontracted and are now canceling excess tonnage. Therefore, present facilities and those contemplated under the approved expansion program should be adequate to satisfy estimated future requirements, especially if existing equipment is modernized and improved. In this connection, a representative described a speeded-up machine which now runs 200 feet a minute faster than previous rates, and with less mechanical difficulty. By adapting this one improvement, he believed, the industry could step-up production by 5 to 10 percent.

The greatest stimulant to increasing newsprint output in the United States, industry representatives concurred, would be a more favorable pricing structure. Because of the low rate of return on newsprint compared with other grades of paper, many manufacturers have shifted their production to more profitable lines. Better prices on newsprint would induce producers to reconvert the machines to newsprint production, they believed. Also, if newsprint distribution were free from political intervention, they felt that the normal working of supply and demand would stabilize the situation.

Although experience indicates that forecasts on production consumption relationships with respect to newsprint are seldom reliable beyond 6 months ahead, a producer said, the results of a study conducted by the Stanford Research Institute at the request of newsprint manufacturers and newspaper publishers on the west coast indicate that existing capacity and contemplated expansions should be adequate to supply estimated requirements in that area at least until 1957. Copies of the report will become available in a few weeks.

Arguments for further expansion were advanced by representatives of companies which are planning extensive expansions and of integrated concerns which consume as well as produce newsprint. From a long-range standpoint, particularly, they considered continuous expansion essential to meet the increasing demand for newsprint, not only by the United States but by the entire world. One representative observed that the high cost of newsprint to publishers contributes to the fact that newspaper publishing in the United States is a "dying industry." A representative from a company which both produces and consumes newsprint disagreed; while there are fewer publishing units, he said, the volume of newsprint consumption is steadily increasing.

Question: How much additional tonnage should be established as the desirable level of expansion? Mr. Tracy explained that the intent of this question is to ascertain how much production in the United States would be necessary to establish a readjusted balance in newsprint production between the United States and Canada.

Industry representatives felt that it is impossible to separate domestic from Canadian production in forecasting the future pattern of supply and demand; consequently, they said that the question could not be answered specifically.

As the United States normally imports between 80 and 90 percent of its newsprint, even a doubling of present domestic production would not approach a 50–50 balance between the United States and Canada, a representative observed; therefore, to contemplate attaining such a balance seemed unrealistic to him.

Question: Should the Government encourage further expansion of newsprint production in the United States? Under the expansion goal approved by DPA, Mr. Tracy noted, 120,000 tons of annual capacity is still available for certification for accelerated tax amortization.

In reply to this question, industry representatives cited actions and regulations of the Department of Agriculture, the Department of the Interior, and the National Park Service which, they said, have deterred increased production. Representatives from the west coast cited the withdrawal of timberland in the Northwest for the establishment of the Olympic National Park. The area is inaccessible to the public, they said, but would provide a perpetual source of raw material sufficient to supply about 800,000 tons of newsprint a year. If this sustained yield of timber had been available for sale to private purchasers, additional newsprint might now be in production in the United States. Several industry representatives recommended that the Government consider releasing this valuable timberland to encourage the expansion of newsprint production in the United States.

Another source of a tremendous quantity of raw material lies in the Tongass National Forest, Alaska, an industry representative pointed out, but the exorbitant cost involved in complying with restrictions imposed by "preventive Government legislation" will not permit utilization of the material. If this timber had been available, additional newsprint might now be in production in the United States.

The removal of other deterrents created by interstate regulations applying to pollution problems, location of chemical plants, water supply, etc., would be helpful, industry representatives said.

Question: Is there a trend toward increasing exports of United States newsprint? Under Office of Price Stabilization controls, the export of newsprint provides no financial advantage to a mill, an industry representative pointed out; further, a trend toward increasing exports is unlikely to develop because North American producers have traditionally tended to satisfy United States demands even when higher prices could have been obtained abroad.

Question: What are the possibilities of expanding newsprint imports from countries other than Canada? While there are possibilities of developing newsprint facilities in New Zealand, South American countries, and other regions, the cost involved would be a major deterrent, industry representatives replied.

Economic considerations. Questions in this series are designed to ascertain whether a substantial increase in newsprint production in the United States is economically practicable, Mr. Tracy explained.

Question: Is the investment necessary to establish additional newsprint production facilities so high as to be a deterrent to further expansion? As a basis of comparison, an industry representative referred to a report from the Canadian Newsprint Association in which the average rate of depreciation for Canadian mills is estimated at $4.06 per ton. According to industry representatives, the estimated rate of depreciation in new mills under construction by United States companies will range from $11.19 to over $25 per ton.

At present interest and tax rates, industry representatives concurred, new mills competing with established mills in either Canada or the United States would be at a substantial disadvantage.

Question: Under present and future market conditions, does newsprint production offer profit opportunities comparable with other end-products in the pulp and paper field? It was the consensus of the group that capital investments in other pulp and paper products would be more profitable considering the low return on newsprint and the continuing political pressure brought on newsprint producers.

Question: Would Government assistance encourage installation of new newsprint production facilities and, if so, what form should this assistance take? Except for one industry representative, the group opposed Government financial assistance in the form of subsidies; representatives also objected to having the newsprint industry singled out to receive or be denied special consideration. Several representatives, however, expressed the opinion that the privilege of applying for Reconstruction Finance Corporation loans or rapid tax amortization certification as authorized under existing legislation should continue to be available to those companies which wish to exercise it. A thought was expressed that active participation by the United States Government in financing new newsprint production facilities, beyond the level of existing legislation, would tend to defeat its purpose through driving existing facilities into production of other grades of paper and paperboard.

The group reiterated the recommendation made previously concerning the removal of deterrents created by Government regulations.

Question: Are present newsprint production facilities in Canada and expansion contemplated in Canada so large as to make expansion of newsprint production in the United States uneconomical? In pointing out earlier that Canadian newsprint manufacturers can operate more economically than United States manufacturers because of the availability of basic resources, etc., industry representatives believed the question had been explored as fully as possible. The only additional suggestion was to consider expansion on the basis of substituting other fibrous materials for wood pulp.

Geographic considerations—including raw materials

Question: Where in the United States is power available at a sufficiently low cost to make production of ground wood pulp for newspring economically practical? Although potential hydroelectric power is plentiful in Alaska, the development costs are exorbitant, an industry representative reported. In the Puget Sound area, the Bonneville system provides an excellent source of power at reasonable rates, he continued, but the lack of other basic resources presents a problem.

In the Colorado area, an industry representative said, there is no additional power available and the cost of expanding hydroelectric facilities is prohibitive. It was further pointed out that there are large deposits of coal in Colorado.

Some additional power capacity may be available in southern areas where natural gas can be utilized, an industry representative said, but the rates under new contracts are substantially above previous levels. The Southern Newspaper Publishers Association has recently conducted a survey on potential resources of the South which might provide an assured supply of newsprint; an industry representative suggested that the Division request a copy of the results from the association.

One industry representative pointed out that mills contemplating expansion have made extensive surveys to determine the most practicable location for a mill; therefore, it would seem that recent selections of sites would indicate the areas where facilities are available.

Question: Are softwoods available in adequate supply to permit substantial expansion of newsprint production, and what are the prospects for substantial production of newsprint from hardwoods? Again, industry representatives referred to the vast quantities of softwood "locked up" in the Olympic National Park and the desirable timber in Alaska which is unavailable because of Government restrictions.

An industry representative expressed the opinion that the availability of softwood in the South would permit considerable expansion of newsprint production,

but another representative questioned this view. He said that the United States Forest Service is investigating the possibility that overcutting has already occurred in southern areas.

The results of experiments on production of newsprint from hardwoods have not yet been determined, industry representatives reported.

Question: What are the prospects of substantially increasing newsprint production by the use of de-inked waste paper, bagasse, wheat straw, or other raw materials? The outlook for general use of newsprint produced from de-inked waste paper appears to be improving considerably, according to an industry representative. He believed that de-inking facilities could be established economically in six or seven locations throughout the United States where collecting of waste paper and distributing of newsprint present no problems. Except when prices of waste paper are unreasonably high, de-inking plants could compete favorably with wood-pulp mills now being constructed, another representative stated; established wood-pulp mills, of course, would have the advantage of lower operating costs.

Experiments with bagasse, wheat straw, and glass fiber are in process, industry representatives reported; from the standpoint of cost, however, a satisfactory substitute for wood pulp has not yet been perfected.

SUMMARY

Although some divergent views were expressed, there was a substantial preponderance of expression that production of newsprint to supply the requirements in the United States must be considered on a broader basis than the territorial limits of the United States. It appeared to the committee members that any hope of reaching a balance under which 50 percent of the United States requirements would be produced within the United States was completely unrealistic. Some limited approach toward such an objective would receive more encouragement through removal of existing restrictive regulations than by financial assistance. The most serious existing restrictions mentioned were the withdrawal from commercial use of large stands of timber in various sections of the United States, with the Olympic National Park in the State of Washington cited as an example; restrictions against shipment of logs from Alaskan forests for processing in the States of Washington and Oregon; and various types of restrictions against economic manufacturing processes such as pollution legislation.

The danger of additional export of newsprint from United States production is not of significance. The possibility of stimulating imports from countries not now shipping to the United States was discussed, but so far as investigations have gone there does not appear an immediate economic possibility of obtaining substantial quantities of newsprint in this manner.

Under existing conditions investment of new capital in newsprint production facilities did not appear to be attractive in the opinion of most of the committee members. In those instances when unusual circumstances indicate the possibility of a successful expansion of newsprint production in the United States, existing forms of Government financial aid should not be withheld, but the committee did not feel the Government should extend financial assistance to the newsprint industry beyond that available to all types of industry in the country.

Present world production of newsprint appears to be large enough to discourage substantial expansion of newsprint production at this time from a competitive economical viewpoint. The industry recognizes that it should be prepared to meet increased demands from newsprint over the years if such an increase develops.

Unless timber now withheld from the market, as mentioned above, is made available, the preponderance of thought in the committee was that softwoods were not available to permit substantial expansion of newsprint in the United States. Also, power at a cost which makes newsprint production economically practicable is available only in a few limited geographic areas. The use of hardwoods in newsprint has not developed sufficiently to obtain an opinion from the committee as to whether that field of raw material offers a practical opportunity for large scale newsprint production.

Several companies are working aggressively toward expansion of newsprint production from de-inked papers. However, by reason of economic problems in assembling sufficient quantity of waste paper, the extent to which newsprint production can be expanded in this manner is somewhat limited.

Developments thus far in the use of fibrous materials other than wood do not lead the committee to expect large scale newsprint production from such materials.

Appendix B

REPORT ON SPECIAL CONFERENCE OF NEWSPRINT MANUFACTURERS BY LYALL TRACY, PRESIDING OFFICER

Office Memorandum, United States Government

June 27, 1952.

To: L. W. Strattner, Assistant Administrator, Chemical, Rubber, and Forest Products Bureau.

From: Lyall Tracy, Director: Pulp, Paper, and Paperboard Division.

The industry representatives whose counsel we sought were very emphatic that the supply of newsprint for consumption in the United States must be considered on a broader geographic basis than the territorial limits of the United States. Considering the tremendous volume of newsprint paper consumed in the United States and the very high percentage of this product now being supplied from Canadian forests through Canadian manufacturing facilities, it was the opinion of this group that it would be practically an impossibility to develop within the United States, production of newsprint in quantities which could appreciably reduce our dependency upon Canadian producers. At least a part of the representatives at the meeting felt the best we could hope for from the expansion of newsprint production from wood within the United States is to maintain the present percentage which newsprint production within the United States is of our newsprint consumption.

In considering the economic questions involved in any substantial increase in production of newsprint at this time, committee members expressed the thought that expansion of production facilities on an international basis to a level considerably above the world demand for the product is not constructive to sound economy. The resultant competition for available markets far exceeds that healthy competition which has resulted in the strong economic development of our country. It develops a situation in which those facilities least advantageously situated to withstand competition become financial failures or divert their production into more attractive fields. New facilities installed at today's high construction costs would be at a serious competitive disadvantage and as a general situation would be likely to be the ones first forced out of the newsprint production field.

When more newsprint production is required certain basic situations must be faced realistically. These situations apply both to new plants which may be installed in this country and those which may be installed in Canada or elsewhere in the world. They are summarized briefly in the next three paragraphs.

New facilities will be at a competitive disadvantage by reason of high construction costs mentioned above. The realistic appraisal of this situation leaves no alternative other than a recognition that the industry requiring the products of such new facilities must make the investment of capital attractive from a long-range investment viewpoint.

Expansion facilities must be installed where fibrous raw material is available. Under present knowledge and at present prices wood is the most practical raw material. The obvious realistic viewpoint is that the expansion in newsprint production must go where the raw material is available at the lowest cost, all cost factors being considered.

Expansion facilities must locate in areas where waste disposal is acceptable. The industry recognizes its responsibility to limit water and air pollution and other inconveniences resulting from its manufacturing processes insofar as that is economically practicable. The industry also recognizes that its waste disposal is not acceptable in densely populated areas.

The location of new production facilities in the industry must be determined on the basis of the three factors mentioned above, as well as others, and these factors appear more favorable toward expansion in Canada, than in the United States, although even in that country there appear limits beyond which further expansion of newsprint production is impractical.

Waste paper appears to be a promising field for a raw-material supply for expansion of newsprint production. Here again, realism requires acceptance of the fact that the industry requiring the product must make it financially attractive to develop newsprint from that raw material. Under existing circumstances there is no evidence supported by experience that newsprint can be produced from reprocessed paper as economically as from wood.

Other fibers do not at the moment appear to be an economically acceptable substitute raw material for newsprint production. There are indications which encourage the expectation of using these substitute materials for other products now consuming wood. To the extent this may be accomplished, it could be presumed to release wood for production of newsprint.

APPENDIX C

MINUTES OF MEETING OF NEWSPAPER INDUSTRY ADVISORY COMMITTEE, JUNE 26, 1952

Merrill Lord, Printing and Publishing Division, NPA, Government presiding officer

COMMITTEE MEMBERS

*P. H. Rice, Augusta Chronicle, Augusta, Ga.
Robert B. Choate, Boston Herald-Traveller, Boston, Mass.
*Roy D. Moore, Brush Moore Newspapers, Canton, Ohio
*Russ Stewart, Chicago Sun Times, Chicago, Ill.
*E. M. Antrim, Chicago Tribune, Chicago, Ill.
Charles F. McCahill, Cleveland News, Cleveland, Ohio.
*Hodding Carter, Delta Democrat-Times, Greenville, Miss.
*Richard W. Slocum, Evening Bulletin, Philadelphia, Pa.
*J. D. Funk, Evening Outlook, Santa Monica, Calif.
*Gene Robb, Hearst Newspaper, New York, N. Y.
Fred S. Seacrest, Lincoln Journal-Star, Lincoln, Nebr.
*Irwin Maier, Milwaukee Journal, Milwaukee, Wis.
*J. S. Gray Monroe Evening News, Monroe, Mich.
Charles E. Moreau, Moreau Publications, Inc., Orange, N. J.
*Charles C. Lane, New York Times, New York, N. Y.
Tams Bixby, Jr., Phoenix and Times Democrat, Muskogee, Okla.
Frank A. Daniels, Raleigh News and Observer, Raleigh, N. C.
*Edward J. Lynett, Scranton Times, Scranton, Pa.
*Franklin D. Schurz, South Bend Tribune, South Bend, Ind.
*George F. Russell, Tacoma News Tribune, Tacoma, Wash.
*Frank W. Mayborn, Temple Daily Telegram, Temple, Tex.
*E. M. Anderson, The Times, Brevard, N. C.
*Thomas L. Kerney, Trenton Times Newspapers, Trenton, N. J.
*Philip L. Graham, The Washington Post, Washington, D. C.

*Samuel H. Kauffmann, Washington Star, Washington, D. C.

GOVERNMENT ATTENDANCE

National Production Authority:

Printing and Publishing Division:

J. Noel Macy
Robert W. Appleton
William G. Chandler
Harold O. Jenkins
Curtis E. Lakeman
Thomas F. Lynch
Robert W. Munson
Lee C. Penry
Donald G. Shook
J. Hale Steinman
Joseph D. Sullivan
Matthew G. Sullivan

Henry H. Fowler, Administrator
J. G. McMullen, Chemical Division
Lawrence W. Strattner, Chemical, Rubber, and Forest Products Bureau
T. H. Mullen, Pulp, Paper, and Paperboard Division
Nathaniel Rafler, Office of Industry Advisory Committees
John R. MacDonald, Office of Public Information
Edward A. Nichols, Office of General Counsel
Marie B. Pfeiffer, Office of Small Business
Edward Moss, Office of Public Information
Dorothy P. Jones, minute writer

Other agencies:

Richard Murphy, Department of Commerce
W. C. East, Small Defense Plants Administration

*Present at meeting.

NOTE.—Industry advisory committees are representative groups formed for the purpose of furnishing advice and information to the National Production Authority on matters furthering the defense effort. No actions are taken or decisions made in these meetings since they are solely for advisory purposes. Suggested subjects for consideration at future meetings may be sent to the Government presiding officer.

PURPOSE OF THE MEETING

The Newspaper Industry Advisory Committee met on June 26, 1952, to discuss the desirability of additional newsprint production in the United States paper and metal supply, the revocation of NPA Order M–65 and other matters. It also considered the current availability of newsprint, the outlook for an adequate sulfur supply, and the status of the defense mobilization plan.

Mr. Merrill Lord (Printing and Publishing Division, NPA) was the Government presiding officer.

RULES GOVERNING INDUSTRY MEETINGS

Mr. Nathaniel Rafler (Office of Industry Advisory Committees, NPA) welcomed the committee and briefly explained, for the benefit of the new members, the purely advisory function of industry advisory committees. He also called attention to the rules applicable to meetings with groups of industry representatives, as revised effective January 2, 1952, copies of which had been given the new members.

INTRODUCTORY REMARKS

Mr. T. H. Mullen (Pulp, Paper, and Paperboard Division, NPA) reported that the paper supply situation has improved to such an extent that the Pulp, Paper, and Paperboard Industry Advisory Committee has recommended the removal of all controls as soon as possible. Acting on this recommendation, consideration is being given to the revocation of Order M–36 (Government order for paper) and the removal of paper and paperboard from the provisions of NPA Regulation 2.

All raw materials essential to the production of paper are in good supply, Mr. Mullen continued; although chlorine and sulfur are still a little tight, supplies appear adequate for the present and the near future.

NEWSPRINT REPORT

Mr. Robert W. Munson (Printing and Publishing Division, NPA) submitted a report on newsprint, covering the general supply-consumption pattern, the methods adopted to handle newsprint distress cases, and the special problems that have arisen in connection with weekly newspapers, the majority of which use "sheeted" newsprint.

Canadian newsprint production during the first 5 months of 1952 was 87,637 tons more than during the corresponding period last year, Mr. Munson reported; United States production was 32,130 tons more. (May production of 103,440 tons was the greatest month's production of newsprint in the United States since 1930.) Imports from Europe were approximately 1,000 tons greater than last year's volume. However, both Canada and the United States are shipping more newsprint abroad; Canada has exported 64,596 tons more than last year and the United States, 43,444 tons. In addition, and in spite of factors which might be expected to inhibit any such trend, domestic consumption has risen by 17,068 tons during the same 5-month period. The only "cushion" against a repetition of the critical supply situation of last year, the report indicated, is an increase above last year's levels of 102,644 tons in publishers' stocks and 26,162 tons in mill stocks; however, these stocks represent only a return to normal inventory position.

The procedure for alleviating newsprint distress cases was established on the basis of procuring, for any publisher unable to obtain as much newsprint as he used in the year 1950, enough paper to print as many pages and to maintain as much net paid circulation as he had in 1950, the report showed. To obtain this newsprint the Printing and Publishing Division called upon large publishers to give up various amounts of newsprint which the division determined was necessary to keep distressed publishers from having to close their doors. In all cases wholehearted cooperation was received from the donors of such newsprint even though the giving in some cases hurt, because the donors in a number of instances had to restock with high cost paper. Coupled with this assistance has been a guaranty that anyone starting a new newspaper would be entitled to a minimum amount of newsprint to publish. The chief beneficiaries under the plan have been not only the smaller daily newspapers, the report revealed, but the religious and labor press and some commercial publication printers as well. During the year of operation (from the beginning of the third quarter of 1951 through the second quarter of 1952) 1,865 tons of newsprint was voluntarily diverted in this fashion to alleviate newspaper distress cases; an additional 611 tons of sheeted newsprint

for weeklies was also granted. In all, 89 applications were received; 35 of these were granted, 22 were denied, 4 are pending, and 24 were dropped by the applicants.

During the first quarter of 1952 the acute needs of 824 weekly newspapers were met, partly through the cooperation of newsprint mills and partly through the assignment of tonnages from large newspapers, the report showed. The majority of these weekly newspapers use flat or sheeted newsprint; primarily because of a lack of standardization of sizes, sheeted newsprint has become more costly for newsprint producers and merchants to handle and is, therefore, less readily procurable. The problem of multiple sizes of sheeted newsprint has been explored and it is hoped that, with the assistance of publishers and of national and regional publishers' associations, the number of sizes may be reduced from the present unreasonable variety to 12 or less. Mills and paper merchants will help, and it is hoped that the discussions currently under way will result in a solution of what has been a recurrent problem, the report concluded.

Mr. J. Noel Macy (Printing and Publishing Division, NPA) commented that the brevity of the report afforded little insight into the magnitude of the distribution accomplishment. In addition to the distress cases handled by the Printing and Publishing Division, publishers' associations assisted many local cases; only those which could not obtain help locally were referred to the Division, he added. The newspaper industry should assume its share of credit for its willingness to help, he believed.

Since the industry is reluctant to publicize its own self-help activities, Mr. Lord asked the committee members to provide him with all data on industry cases being cared for in their own areas. The information will be added to what is officially available to form the basis for an over-all report for general release, he added.

DISCUSSION OF ADDITIONAL NEWSPRINT PRODUCTION

Mr. Richard Murphy (Office of Industry and Commerce, Department of Commerce) read a statement outlining the proposed report of the Department of Commerce in respect to the manufacture of newsprint. The Antitrust Subcommittee of the House Judiciary Committee has requested the Department to draft a report on the desirability and possibility of the expansion of newsprint production in the United States. The Printing and Publishing Division, together with other NPA offices and other interested parties, has been asked to cooperate in preparing the data for the report, Mr. Murphy added. That the House subcommittee is fully aware of the special problems involved is evidenced he believed, by the following statement in its June 5 report: "The problems involved in the recent newsprint price rise are manifold and complicated and there can be no immediate solution to either the rising cost of newsprint or the shortage of newsprint paper in view of the numerous factors which have been outlined heretofore." The subcommittee, he explained, hopes that the requested report will help solve the problems. In addition Mr. Lord pointed out NPA's responsibilities on these problems.

To ascertain the committee's views, Mr. Lord presented a series of specific questions, the answers to which he felt would reflect the newspaper industry's views on the subject.

Question: In November 1951, a DPA expansion goal for 494,000 tons of additional newsprint production was approved. To date, only 375,000 tons of additional production has been proposed in TA applications. In view of these facts, would you recommend that any change be made at this time in the present goal?

The committee favored a continuance of the established goal. However, committee members urged that the goal be expanded when and if specific applications are filed that might exceed any remaining portion of the existing goal.

Attainment of the goal of 494,000 tons of additional newsprint production would give the United States a total capacity in 1953 of approximately 1,700,000 tons, which slightly exceeds the historical production maximum, Mr. Lord explained. At the present time less than 20 percent of the domestic consumption is being met by domestic production; a committee spokesman expressed the opinion that not since 1900 has the domestic supply of newsprint been sufficient to meet the needs of the United States. The majority of the committee concurred in the view that the planned tonnage will be absorbed regardless of newsprint conservation programs that have been undertaken, rising prices, or any other considerations.

Certain members of the committee strongly emphasized that no person who wished to enter the newsprint production field should be deterred from doing so because of the fact that the planned goal had been reached.

Question: Would you recommend that the Government take further steps to encourage expansion of newsprint production in the United States? If so, what steps do you suggest be taken? If not, why not?

A committee spokesman ventured the opinion that the Government would best encourage the expansion of newsprint production in the United States by making more readily available the raw materials necessary for that production. He called attention to two areas in the Northwest—one on the Olympic Peninsula, the other the Tongass National Forest in Alaska—he said the former could, under proper safeguards to assure perpetuation of the natural resources, provide a perpetual supply of raw material. The development of these raw material sources would assure a supply for the production of 800,000 tons of newsprint a year, he estimated.

The timberlands in the Olympic National Park, at present inaccessible for any public purpose, would benefit from proper logging operations, the committee member emphasized.

Mr. Macy discussed the laws and regulations which govern the use of national parks and national forests. Under the legal provisions, proper use of forests is permitted if such use will preserve the natural resource, but a park may be used only for a park. He cited, as an example, the restrictions against the use of any section of Yellowstone National Park as grazing land; yet the adjoining national forest may be used for that purpose.

There is no restriction against logging operations in Tongass National Forest in Alaska, a committee man explained, but the Department of Agriculture has ruled that logs cut from the forest must be processed in Alaska. Hydroelectric power is not now available there and cannot be economically installed; if logs cut in Alaska could be brought to the Puget Sound area, where power, labor and manufacturing facilities are available, newsprint could be produced without Government assistance of any kind, he emphasized. Bonneville is interested in bringing an industrial payroll into its district, and the diversion of logs from Alaska would benefit the area immeasurably, he contended.

The committee recommended that a study be made of the possibility of utilizing pulpwood, timberlands, such as those on the Olympic Peninsula and in Alaska, for the production of forest products, including newsprint, under proper restrictive safeguards which would assure the perpetuation of the natural resource.

Question: To what extent are newspaper publishers willing to finance further expansion of newsprint production in the United States?

The committee was generally of the opinion that newspaper publishers would provide reasonable amounts of equity capital to start new mills. Members wished to withhold a definite commitment as to the extent of the investment until a specific offering is made.

Many factors would influence such an investment, committee members explained. Capital investments in other paper products provide a better financial return than newsprint, it was pointed out. It was generally believed, however, that publishers would invest in newsprint mills if the raw materials for newsprint production were available.

Question: Would you recommend that the Government give financial help other than tax amortization, either separately or jointly with newsprint producers or consumers?

The committee stated that it is not opposed to Government loans per se but that the newspaper industry will not seek them and will avoid any which might affect the independence of the newspaper business.

Several members of the committee expressed themselves as opposed to the principle of Government financial assistance to newsprint mills. Such assistance should be forthcoming only after it is shown that private investment capital cannot be obtained, they argued. Other members, however, believe that the privilege of applying for Reconstruction Finance Corporation loans should not be denied.

Question: What are your views as to the practical prospects for newsprint made from materials other than pulpwood, such as de-inked paper, bagasse, or wheat straw?

Newsprint made from de-inked paper has improved considerably, an industry representative reported, but is not available at a cost comparable with regular newsprint. Mr. Lord told the committee that experiments being conducted have resulted in the production of an apparently good grade of newsprint from de-inked paper at less cost than prevailing newsprint prices. He asked whether the committee felt that the cost of producing newsprint from de-inked paper would be any higher than the cost of groundwood newsprint if the plants were located near sources of good supply of newspapers and magazines.

A committee member replied that the end price of newsprint produced from de-inked paper will depend upon the price of the raw material, not the proximity to the source of supply; since used newspapers are usually in great demand for the production of paperboard, the price fluctuates widely with the demand for board, he explained. Several committee members added that their experiences in times of critical waste-paper shortages would support this viewpoint.

Technical developments have not yet overcome the opacity of newsprint made of bagasse, a committee member reported. Mr. William G. Chandler (Printing and Publishing Division, NPA) briefly reviewed some of his own experiences with bagasse. One of its greatest disadvantages, he explained, is that the raw material does not keep, so that as a raw material for the production of newsprint it would be available only for a very limited period of time each year. In addition, bagasse is being used in Hawaii for wallboard and for packaging materials, so that competition for the material is growing.

Mr. Murphy commented that the Bureau of Standards is conducting tests on bagasse, among other fibers, as part of the program being undertaken to reach a decision on newsprint expansion.

The committee concluded that de-inked paper, bagasse, and wheat straw are not as yet practicable substitutes for pulpwood in the production of newsprint.

As a final question, Mr. Lord asked whether the committee would like to make any other suggestions as to what the Government might do to encourage further expansion of newsprint production in the United States. The committee had no suggestions other than those already advanced.

STATUS OF THE DEFENSE MOBILIZATION PROGRAM

The defense mobilization program has progressed only halfway toward its established goal and any tendency to relax efforts to reach the planned objectives is to be deplored, Mr. Henry H. Fowler (Administrator, National Production Authority) told the committee. Although the program is proceeding satisfactorily, there is no justification for undue optimism, he added.

Mr. Fowler recalled that the direct military objective was predicated on the expenditure of $132 billion over a period of 3 years to equip additional divisions of the Army, a 143-group Air Force, and a 400-ship Navy. Of the total appropriation, analysis of a statistical chart revealed, approximately $75 billion has been obligated for outstanding contracts; deliveries in terms of military end products and finished facilities, as of the 1st of June 1952, totaled $28 billion. It is obvious, Mr. Fowler pointed out, that substantial amounts remain in the pipelines.

The rate of procurement of military items for the second quarter of 1952 is expected to show an increase of 20 percent over the first quarter, Mr. Fowler said. If this increase is attained, the rate of procurement and construction will be six times greater than that which applied at the time of the invasion of Korea 2 years ago, he added. Deliveries of 120 major military items rose 50 percent in value in the period between February and May. Deliveries of military hard goods and hard-to-get items by December of this year are expected to be double those made in December 1951, with military aircraft deliveries increasing 2½ times, Mr. Fowler continued. He expressed the opinion that a fairly steady rate of delivery, which might be maintained until the end of the 1953 fiscal year (mid-year 1954), would not be attained within less than 6 to 8 months.

In discussing the industrial plant expansion program, Mr. Fowler called attention to a report released by the Defense Production Administration, entitled "Industrial Growth," from which he quoted: "We have passed the halfway point in our expansion program. About 52 percent of the new facilities planned for under present mobilization goals is in place. By the end of this year, two-thirds of planned expansion is expected to be in place, and by the end of 1953 the expansion program is expected to be 94 percent complete." This report reveals, he pointed out, that of the $15 billion plant expansion program approved through March 1952, only 119 loans for $165 million were applied for and approved. The tremendous plant expansion has been accomplished this time through the incentive of tax amortization, he believed.

The turning point in the industrial expansion program has been reached, Mr. Fowler continued. He distributed to committee members copies of DPA press release No. 369, covering tax amortization and expansion goals, which advises industry that no more industrial expansion requiring tax amortization should be planned without prior consultation with Government agencies responsible for the particular industry involved. The Government has released a list of industries for which it is still soliciting additional applications in order to meet the expansion

goal, Mr. Fowler said; the press announcement lists these industries in that open area and indicates that unless the facilities in question are included, the Government is not interested from a tax amortization point of view. Exceptions will, of course, be made, but on a selective basis.

The defense production agencies will try to locate any narrow and specialized industrial gaps in the mobilization requirement program, Mr. Fowler said. It is especially important that these specialized gaps be provided for when they occur in long-lead-time production, such as heavy castings, which can become serious bottlenecks in the event of an all-out emergency, he added.

The most difficult period lies ahead, Mr. Fowler believed. In the mobilization program, problems have developed which could not have been anticipated at the time the original plan was set in motion. He cited as an example the problem of maintaining military production lines on a repetitive basis, after mobilization objectives are attained. The plane planned in 1952 may be obsolete in 1956, and lead times of 5 to 7 years are required for aircraft, jet engines, and many other military items, he pointed out.

Mr. Fowler believed that the tendency of the general public to equate the announcements of decontrol measures with the end or accomplishment of the mobilization effort is very unfortunate. In the early days of control, an attempt was made to augment the supplies of raw materials; as these supplies improve, production and material controls are being relaxed or eliminated. These measures are being taken on a selective basis, not across the board, he emphasized.

Mr. Fowler concluded by expressing the opinion that the mobilization of armed strength is the most important single task facing the Nation. The program was based upon an unmistakable threat to national security and no recent occurrence has lessened that threat. Mobilization objectives, when attained, must be maintained, he believed.

SULFUR OUTLOOK

A committee member read part of the text of a letter he had directed to the Printing and Publishing Division, expressing concern over the future sulfur supply. Various companies in Canada have undertaken to develop an alternate supply of sulfur for newsprint manufacture, from pyrites, liquid sulfur dioxide, sour gases, and other sources, but this new production is expected to yield only about 100,000 tons of sulfur equivalents annually, or about one-third of the total requirements of the Canadian newsprint industry.

Mr. Lord commented that this letter is not the only indication that the sulfur supply situation is causing concern.

Mr. J. G. McMullen (Chemical Division, NPA) agreed that the long-range elemental sulfur outlook is serious. An expansion goal of 8½ million tons by 1955 is considerably undersubscribed, he explained, primarily because it is expensive to install mills and the only incentive that can be offered is tax amortization. Some producers, he believed, were doubtful of the size of the goal, but normal rate of growth data compiled over a period of years indicate that the amount is not unreasonable.

Canada has been given equivalent treatment with the United States insofar as sulfur allocations are concerned, Mr. McMullen continued. Both countries have been restricted to 90 percent of their 1950 base-period usage, but adjustments have brought the actual allocations closer to 100 percent. The Canadian equivalent of the National Production Authority is hopeful that, by 1953, the new sulfur production will enable Canada to reduce its receipts from the United States. Until then, Mr. McMullen believed that the present allocations would be continued.

Present production of elemental sulfur, Mr. McMullen said, is 5,400,000 tons annually. An additional 500,000 tons is anticipated next year, but not before the latter part of the year; this will still leave an elemental sulfur shortage in prospect for 1953. Considerable progress has been made in the conservation of sulfur, he added.

Including the elemental sulfur, an estimated 7½ million tons of equivalent sulfur, from zinc ores, pyrites, sour gases, etc., may be anticipated, Mr. McMullen explained. At the present time, adequate supplies of sulfur are available, but not in the cheaper grades.

NEWSPRINT CONSERVATION MEASURES

The Boston plan.—The Boston plan, a plan to conserve newsprint, is being abandoned by NPA because of the Department of Justice requirement that its

Antitrust Division be furnished reports concerning its progress, Mr. Lord told the committee.

The plan was set up as a conservation measure under section 708 of the Defense Production Act, and permitted an agreement allowing publishers to limit the percentage of unsold copies of newspapers, Mr. Macy reminded the committee. It took its name from the first and only city for which the plan was approved, and where it resulted in the saving of appreciable amounts of newsprint. A misunderstanding developed concerning the right of the Department of Justice to see the reports submitted to NPA and since the views of NPA and the Department of Justice with regard to submitting them are irreconcilable, the decision was reached to withdraw the plan.

Reduction of column widths.—The use of narrowed column widths was discussed (from 12 to 11.4 picas). It was estimated that such a contraction would permit the reduction of newspaper rolls in metropolitan cities from 64 or 63½ inches to 60 inches, and result in a national saving of nearly 250,000 tons of newsprint annually.

Many of the major newsprint users, the committee member commented, have been investigating the possibility of standardizing narrower column widths; it is hoped that the movement will have the support of national advertisers. The ANPA has appointed a committee to study the possibility of standardization from every aspect, including the effect of the adoption of any plan upon the mills, he added.

Another committee member reported that a conference of the Newspaper Advertising Executive Association held recently at Daytona Beach adopted a resolution urging that serious consideration be given the project of standardizing a narrower column width in order to effect newsprint conservation. The advertisers and executives pointed out that the efforts being made to conserve newsprint by high shrinkage often result in distortion; they favor standardization and the making of mats and electros to conform to any standardized width.

The committee reported that the newspaper industry plans further study and experimentation and will make its final recommendations and findings available to the Printing and Publishing Division as suggestions toward the further conservation of newsprint.

GENERAL

Small business problems.—No small newspaper suffers from problems pertinent to its size, Mr. Lord told the committee. Of the 11,000 newspapers in the United States, he estimated that approximately 10,500 are small businesses; because of the solidarity and family spirit of the newspaper industry, none of these has suffered unduly from shortages of any kind of raw materials.

APPENDIX D

REPORT ON TIMBER SUPPLIES FOR EXPANDED PRODUCTION OF NEWSPRINT

This statement has been prepared by the United States Forest Service for inclusion in a comprehensive report on newsprint being submitted by the Department of Commerce to the Subcommittee on Monopoly of the House Committee of the Judiciary. The purpose of this statement is to indicate the availability of timber resources in the United States and Alaska for possible expansion of the domestic newsprint industry.

This statement considers both softwoods such as spruce, fir, and southern pine, which have been the conventional species used for newsprint production, and also hardwoods which in the past have not been used for newsprint but which as a result of technological developments now have promising possibilities for such use. In appraising the availability of timber supplies it is necessary to consider possible expansion of the pulp, paper and board industry in a general way, rather than for newsprint production only, since the kind of paper that industry produces is determined not only by availability of pulpwood timber supplies but also by various other cost and market factors.

THE GENERAL FOREST SITUATION

As background for appraising local possibilities for expansion of newsprint output the general condition of the timber resource in the United States and Alaska is of considerable significance. The pulp and paper industry is in direct competition with the lumber industry and many other wood-using plants for its wood requirements, particularly for softwoods which are preferred for newsprint.

About one-fourth of the United States—or 460 million acres—is commercial forest land suitable and available for the growing of timber crops. This land has the capacity ultimately to grow all the timber that forest industries seem likely to require. However, at the present time, current growth is not sufficient to sustain the present drain for lumber, pulp, and other forest products. The most recent comprehensive appraisal of our forest resources in 1945 indicated that growth and drain of all sizes and kinds of timber were approximately in balance (table 1).

TABLE 1.—*Timber volumes, growth, and drain in the United States, 1945*

Species	All timber (billion cubic feet)			Saw timber (billion board feet)		
	Volume	Growth	Drain	Volume	Growth	Drain
Softwoods	321	6.8	8.2	1,301	21.8	38.5
Hardwoods	148	6.6	5.5	316	13.5	15.4
Total	469	13.4	13.7	1,617	35.3	53.9

However, growth of trees of saw-timber size, which provide most of the raw material for forest industries, was only about two-thirds of the total drain. Lumber accounts for about 63 percent of the total drain on United States forests, pulpwood 14 percent, and other products 23 percent.

Preferred softwood species also are being heavily overcut, whereas hardwoods, many of undesirable species, are in general increasing. Thus in 1945, total softwood growth amounted to 83 percent of softwood drain, whereas hardwood growth exceeded hardwood drain by 20 percent (table 1). The deficiency in softwood growth was even more marked in the case of saw-timber size material. This overcutting of softwoods is of particular significance to the pulp and paper industry since about 86 percent of the total cut of pulpwood, and essentially all the wood used for newsprint, is comprised of softwoods.

The deficiencies in current growth largely reflect widespread understocking of timber stands. The volume of softwood growing stock in the eastern United States, for example, needs to be nearly doubled if it is to produce a reasonable share of estimated future requirements for timber products. In the West where old-growth timber predominates growing stock is more adequate but it is important to note that more than three-fourths of all commercial forest lands are in the eastern United States.

Progress in timber management has been encouraging but protection and cutting practices are still not adequate to insure that raw material needs of all forest industries will be met in the future. On public holdings management is generally satisfactory but public holdings make up only one-fourth of our commercial forest lands and provide only about 10 percent of the current cut of timber products. Cutting practices on the larger private holdings of pulp and lumber companies are also relatively good, but these properties comprise only about 13 percent of the Nation's commercial forest land.

On the remaining three-fifths of the commercial forest area which is in small and medium-sized holdings, management practices are generally poor. In 1945 cutting was "good or better" on only 4 percent of these smaller holdings. More than 4 million owners hold these small properties, which average only about 70 acres, yet these poorly managed forests in small holdings constitute the chief source of raw material for the pulp and paper, lumber, and other wood-using industries.

The pulp and paper industry has been acquiring land at a rapid rate in recent years and now owns possibly 20 million acres, or about 4 percent of the commercial forest lands in the United States. It has become increasingly difficult to block-up timber properties of efficient size, however, primarily because of the small size, high cost, and scattered location of timber holdings that are for sale today. Any new newsprint mill in the United States, therefore, faces a serious problem of acquiring sufficient timberland to supply a substantial part of its own wood requirements. In the East, pulp and paper mills must depend largely upon procurement of wood from small private holdings. In the West, mills will probably have to depend largely upon large private holdings and upon the national forests and other public holdings.

OPPORTUNITIES FOR NEWSPRINT PRODUCTION IN ALASKA

From a timber supply standpoint, the most promising opportunities for expansion of the newsprint industry based upon the conventional use of softwoods, are to be found in southeastern Alaska. The 5 million acres of commercial forest land in the national forests of southeastern Alaska support an estimated stand of 84 billion board feet which could support permanently production of 1 million tons annually of pulp and paper, plus some lumber and other timber products.

A new plant to manufacture wood pulp is now under construction in southeastern Alaska, utilizing wood from the Tongass National Forest under a 50-year contract. Plant sites and timber supplies are also available for several additional mills of large size.

Alaskan timber, consisting of about three-fourths hemlock and one-fourth spruce and other species, is especially suitable for the manufacture of newsprint. Large water-power resources can be developed far in excess of possible demands of newsprint mills. Adequate supplies of suitable water are also available at numerous mill sites. The climate of southeastern Alaska is similar to that of the Pacific Northwest and as a result a logging season of 9 to 10 months is feasible in this region. A network of deep-sea channels throughout southeastern Alaska provides a main-line transportation system for logs from all parts of the forest area and consequently tends to favor low logging costs. Although Ketchikan is 700 nautical miles from Seattle and 95 miles from Prince Rupert on the Canadian National Railway System, the tidewater location of prospective mills and the feasibility of water transportation by the protected inside passage also favors low transportation costs for manufactured products. In many respects an Alaskan pulp and paper industry would merely represent an extension of the industry that has been long established on the west coast of Oregon, Washington, and British Columbia.

In the past, several factors have militated against the development of Alaska, including relatively high wage rates, transportation uncertainties, and the existence of Indian claims to portions of the Alaska timber. However, the Tongass Timber Act of 1947 (23 Stat. 26, 1100; 31 Stat. 330, 48 U. S. C. 356) provided for sale of national forest timber notwithstanding any claim of possession rights. With the changing economic situation and the increasingly serious problems of timber supply facing the pulp and paper industry, it is believed that Alaska will

become an increasingly attractive location for expansion of newsprint or other pulp and paper products.

Large mills are the rule in newsprint industry and there are few places where it is possible to block up the huge supply of timber needed to justify installation of new plants. In administering the commercial forests in southeast Alaska the Forest Service, Department of Agriculture, will follow a policy of managing these timberlands primarily for pulp timber on a sustained-yield basis. Adequate timber is available for large new pulp mills in Alaska on terms that will safeguard the public interest involved in this public timber and also provide reasonable security to plant investments.

Timber cut from the national forests of Alaska must be given at least primary manufacture into lumber or pulp, for example, before shipment from the Territory. This requirement is contained in regulation S–3, Secretary of Agriculture (sec. 221.3 of title 36, Code of Federal Regulations). It would thus be possible, for example, to manufacture groundwood and chemical pulp in Alaska for shipment to newsprint-producing mills in the States. The executive and legislative branches of the United States Government, Territorial officials, and other Alaskan groups have all stressed the need for further economic development of Alaska. The policy of requiring that national-forest timber be manufactured into primary products in the Territory is in line with the objective of fostering development which will enhance the economic and military strength of Alaska.

OTHER OPPORTUNITIES FOR EXPANSION BASED UPON USE OF SOFTWOODS

In the continental United States opportunities for newsprint expansion based upon softwood-timber supplies appear somewhat less promising. In the Rocky Mountain region there are available timber resources that would support a few pulp and paper mills, including newsprint mills. Although promising from a timber-supply standpoint, locations in the Rocky Mountain area in the past have not been considered as especially promising because of such factors as distance to markets, high costs of logging, and problems of water supply.

On the west coast where about one-third of the domestic newsprint is produced, timber supplies are available for increased pulp and paper production based primarily upon the use of Douglas-fir sawmill and logging waste, and upon little-used species such as lodgepole pine. However, these species are primarily suitable for kraft pulp rather than for the groundwood pulp normally used in newsprint. Substantial volumes of the former "pulping" species such as western hemlock, fir, and spruce still remain (table 2) but such timber is mostly blocked up in public or large private holdings and competition has become increasingly keen for these species upon which the pulp and paper mills in this region, including newsprint mills, have largely drawn in the past.

Forests of the southern United States are today providing more than half the total pulpwood cut in the United States. The rapidly expanding pulp industry in this region is based largely upon production of kraft pulp and paper from southern pine. Only about 13 percent of the pulpwood produced in 1951 was hardwood; 2 of the 74 pulp mills in the South manufacture newsprint, and although the industry in this region is still expanding, only 1 new newsprint mill is reported to be under construction.

Further expansion of the pulp and paper industry in the South must be carried out in the face of declining supplies of available southern pine timber. Practically all wood-using industries, including the important lumber industry, prefer pine rather than hardwoods with the result that pine timber resources are still decreasing whereas hardwood resources are increasing. There will probably be further expansion of the pulp industry in the South but such expansion must be at the expense of the timber resource or the lumber industry and other wood-using plants—unless the timber raw material supply situation is materially improved through better forest management, more intensive utilization of woods and mill waste, or the use of hardwoods in lieu of softwoods.

In the Northeastern and Lake States, which together supply about 25 percent of the pulpwood cut in the United States and more than half of the domestic output of newsprint, there appears to be little opportunity for expansion of newsprint or other paper based upon the use of softwoods. Primarily as a result of dwindling supplies of spruce, fir, and other local softwoods, the industry in these regions has been forced to import large volumes of pulpwood and wood pulp, and to an increasing degree shift to the use of local hardwoods.

TABLE 2.—*Volume of saw timber in the United States, by species, 1945*

Species	Volume (million board feet)	Percent of total	Species	Volume (million board feet)	Percent of total
Eastern softwoods:			Other softwoods	134,846	8.3
Southern pines	189,116	11.7	Total	1,037,167	64.1
Spruce and fir	26,448	1.6			
White and red pines	17,293	1.1	Hardwoods:		
Hemlock	15,937	1.0	Oak	109,608	6.8
Other softwoods	15,403	1.0	Beech, birch, and maple	68,771	4.3
			Sweetgum	24,732	1.5
Total	264,197	16.4	Tupelo and blackgum	19,467	1.2
			Cottonwood and aspen	15,185	.9
Western softwoods:			Other hardwoods	78,011	4.8
Douglas fir	430,028	26.6			
Ponderosa pine	185,441	11.5	Total	315,774	19.5
True firs	113,541	7.0			
Western hemlock	97,207	6.0	Total all species	1,617,138	100.0
Spruce	35,880	2.2			
Sugar and white pines	40,224	2.5			

OPPORTUNITIES FOR EXPANSION BASED ON THE USE OF HARDWOODS

In the eastern United States there are many opportunities, from a timber supply standpoint, for expansion of the pulp and paper industry based upon use of hardwoods. Growth of hardwoods exceeds drain as indicated in table 1, and there are in addition large volumes of cull hardwood trees which are also potentially suitable for processing into pulp and paper.

Various species of oak account for about one-third of the total volume of hardwoods (table 2). Beech, birch, and maple are of large importance in the Northeast and the Lake States regions. In the South, sweetgum, tupelo, and blackgum are second only to oaks in abundance. In the past much of the hardwood used for pulp has consisted of the soft hardwoods such as gum, cottonwood, and aspen. From a timber-supply standpoint, however, it would be desirable to place increasing reliance upon the hard hardwoods, such as oaks and hickories, for expansion of pulp and paper production. If such species are utilized the hardwood timber resource of the East is adequate to support a pulpwood drain many times greater than the cut in recent years.

In conclusion, it is apparent from the foregoing discussion, that the best opportunities for expansion of the domestic newsprint industry are to be found in the softwood forests of Alaska and the hardwoods of the eastern United States. In most other areas, further expansion of the pulp and paper industry based upon species conventionally used is likely to have serious impacts either upon the timber resource or upon other wood-using industries. In the short run adverse impacts on timber resources may be lessened by more intensive utilization of material formerly wasted in the woods and mills, by more intensive timber protection and management, and by greater use of hardwoods as a substitute for, or supplement to, declining supplies of the preferred softwoods. The long-term needs of the pulp and paper industry and of other wood-using industries can be assured only through expanded forest conservation programs that will be more comprehensive and more effective than programs now in effect.

APPENDIX E

BASIC FOREST STATISTICS FOR THE UNITED STATES AS OF JANUARY 1945

(Tables 1–6 and table 10 contain revised data for six States covered by the forest survey since 1945)

Forest Service, United States Department of Agriculture, Washington

TABLE 1.—*Land area of the United States, by major uses, and by State and region* [1]

[In thousands of acres]

State and region	Total land area	Forest land					Crop land in farms	Pasture and range [5]			Other [6]
		Total	Commercial [2]	Noncommercial				Total	In farms	Not in farms	
				Total	Withdrawn [3]	Other values [4]					
New England:											
Connecticut	3,135	1,907	1,900	7	7	----	642	117	117	----	469
Maine	19,866	16,788	16,665	123	103	20	1,589	352	352	----	1,137
Massachusetts	5,060	3,310	3,297	13	12	1	788	234	234	----	728
New Hampshire [7]	5,775	4,848	4,682	166	25	141	461	280	280	----	186
Rhode Island	677	452	447	5	5	----	93	13	13	----	119
Vermont	5,938	3,835	3,820	15	----	15	1,478	446	446	----	179
Total	40,451	31,140	30,811	329	152	177	5,051	1,442	1,442	----	2,818
Middle Atlantic:											
Delaware	1,266	442	442	----	----	----	570	24	24	----	230
Maryland	[8] 6,367	2,742	2,722	20	18	2	2,585	178	178	----	[8] 862
New Jersey	4,814	2,348	2,329	19	17	2	1,157	157	157	----	1,152
New York	30,675	13,500	11,114	2,386	2,358	28	10,237	3,951	3,951	----	2,987
Pennsylvania	28,829	15,228	15,127	101	96	5	9,240	1,469	1,469	----	2,892
West Virginia	15,418	9,954	9,852	102	----	102	3,861	771	771	----	832
Total	87,369	44,214	41,586	2,628	2,489	139	27,650	6,550	6,550	----	8,955
Lake:											
Michigan	36,494	19,000	17,380	1,620	552	1,068	11,899	1,259	1,259	----	4,336
Minesota	51,206	19,700	16,700	3,000	500	2,500	22,974	2,523	2,382	141	6,009
Wisconsin	35,018	17,000	16,265	735	86	649	13,038	2,245	2,240	5	2,735
Total	122,718	55,700	50,345	5,355	1,138	4,217	47,911	6,027	5,881	146	13,080

See footnotes at end of table, p. 83.

TABLE 1.—*Land area of the United States, by major uses, and by State and region* [1]—Continued

[In thousands of acres]

State and region	Total land area	Forest land					Crop land in farms	Pasture and range [5]			Other [6]
		Total	Commercial [2]	Noncommercial				Total	In farms	Not in farms	
				Total	Withdrawn [3]	Other values [4]					
Central:											
Illinois [7]	35,806	3,996	3,941	55	54	1	21,433	5,054	5,054	----	5,323
Indiana	23,171	3,445	3,358	87	87	----	14,650	1,021	1,021	----	4,055
Iowa	35,831	2,248	2,226	22	22	----	27,548	2,784	2,784	----	3,251
Kentucky	25,670	11,857	11,694	163	80	83	11,200	874	874	----	1,739
Missouri [7]	44,333	15,187	15,074	113	37	76	13,941	12,553	12,533	----	2,652
Ohio	26,318	4,831	4,779	52	52	----	15,658	3,011	3,011	----	2,818
Total	191,129	41,564	41,072	492	332	160	104,430	25,297	25,297	----	19,838
Plains:											
Kansas	52,552	1,121	1,011	110	10	100	34,193	16,638	12,473	4,165	600
Nebraska	49,058	1,112	987	125	25	100	25,415	21,931	18,942	2,989	600
North Dakota	44,835	621	470	151	15	136	27,101	13,324	7,954	5,370	3,789
Oklahoma (west) [9]	38,250	6,326	----	6,326	----	6,326	18,423	11,706	8,831	2,875	1,795
South Dakota (east) [10]	45,244	662	618	44	----	44	22,541	21,641	12,288	9,353	400
Texas (west) [9]	150,077	25,986	240	25,746	4	25,742	40,921	75,743	64,163	11,580	7,427
Total	380,016	35,828	3,326	32,502	54	32,448	168,594	160,983	124,651	36,332	14,611
Total North	821,683	208,446	167,140	41,306	4,165	37,141	353,636	200,299	163,821	36,478	59,302
South Atlantic:											
North Carolina	31,451	18,400	17,997	403	332	71	8,422	909	909	----	3,720
South Carolina [7]	19,328	11,943	11,900	43	40	3	4,949	866	866	----	1,570
Virginia	25,535	14,832	14,377	455	271	184	7,962	1,036	1,036	----	1,705
Total	76,314	45,175	44,274	901	643	258	21,333	2,811	2,811	----	6,995
Southeast:											
Alabama	32,690	18,878	18,800	78	61	17	10,397	621	621	----	2,794
Florida [7]	34,479	23,047	21,451	1,596	46	1,550	2,315	4,568	4,568	----	4,549
Georgia	37,452	21,432	21,107	325	227	98	11,690	732	732	----	3,598
Mississippi [7]	30,349	16,533	16,509	24	24	----	7,436	4,233	4,233	----	2,147
Tennessee	26,855	12,165	11,850	315	254	61	11,159	1,622	1,622	----	1,909
Total	161,825	92,055	89,717	2,338	612	1,726	42,997	11,776	11,776	----	14,997
West Gulf:											
Arkansas	33,744	20,036	19,938	108	16	92	10,190	715	715	----	2,803

Total	161,825	92,055	89,717	2,338	612	1,726	42,997	11,776	11,776		14,997
West Gulf:											
Arkansas	33,744	20,036	19,928	108	16	92	10,190	715	715		2,803
Louisiana	28,915	16,196	16,169	27	10	17	6,038	806	408	398	5,873
Oklahoma (East) [9]	6,091	4,320	4,308	12	7	5	1,238	135	135		398
Texas (East) [9]	18,653	10,567	10,548	19	4	15	5,340	850	850		1,898
Total	87,403	51,119	50,953	166	37	129	22,806	2,506	2,108	398	10,972
Total South	325,542	188,349	184,944	3,405	1,292	2,113	87,136	17,093	16,695	398	32,964
Pacific Northwest:											
Douglas-fir subregion	35,119	29,145	26,027	3,118	1,032	2,086	2,749	1,576	1,533	43	1,649
Pine subregion	69,410	24,710	20,177	4,533	472	4,061	9,686	34,335	12,579	21,756	679
Total	104,529	53,855	46,204	7,651	1,504	6,147	12,435	35,911	14,112	21,799	2,328
Oregon	61,664	29,755	26,330	3,425	448	2,977	5,255	25,888	8,866	17,022	766
Washington	42,865	24,100	19,874	4,226	1,056	3,170	7,180	10,023	5,246	4,777	1,562
Total	104,529	53,855	46,204	7,651	1,504	6,147	12,435	35,911	14,112	21,799	2,328
California	100,354	45,515	16,405	29,110	705	28,405	11,899	15,366	9,373	5,993	27,574
North Rocky Mountain:											
Idaho	52,997	18,813	10,149	8,664	269	8,395	4,708	28,185	3,793	24,392	1,291
Montana	93,642	24,238	14,758	9,480	673	8,807	14,789	52,751	28,628	24,123	1,864
South Dakota (west) [10]	3,739	1,317	1,147	170	65	105	628	1,755	1,270	485	39
Wyoming	62,404	8,878	3,012	5,866	1,869	3,997	3,513	48,942	23,746	25,196	1,071
Total	212,782	53,246	29,066	24,180	2,876	21,304	23,638	131,633	57,437	74,196	4,265
South Rocky Mountain:											
Arizona	72,691	19,538	2,815	16,723	332	16,391	993	48,866	11,842	37,024	3,294
Colorado	66,539	19,902	7,874	12,028	800	11,228	12,899	32,478	15,601	16,877	1,260
Nevada	70,273	4,720	98	4,622		4,622	862	58,789	2,636	56,153	5,902
New Mexico	77,767	20,001	3,465	16,536	710	15,826	4,573	52,627	26,445	26,102	566
Utah	52,701	8,494	1,530	6,964	41	6,923	1,762	36,465	4,908	31,557	5,980
Total	339,971	72,655	15,782	56,873	1,883	54,990	21,089	229,225	61,432	167,793	17,002
Total West	757,636	225,271	107,457	117,814	6,968	110,846	69,061	412,135	142,354	269,781	51,169
Total all regions	1,904,861	622,066	459,541	162,525	12,425	150,100	509,833	629,527	322,870	306,657	143,435

[1] Prepared by Forest Service, U. S. Department of Agriculture. Status beginning of 1945, except for States footnoted 7.

[2] Land capable of producing timber of commercial quantity and quality, and available now or prospectively for commercial use.

[3] Commercially valuable land in parks, preserves, etc., withdrawn from timber use.

[4] Land chiefly valuable for purposes other than timber production, such as oak-cedar breaks of Texas and Oklahoma, mosquito, pinon-juniper in the West, chaparral in southern California, remote and inaccessible alpine ranges, and other areas which appear to be permanently out of the commercial timber-producing class because of low productivity or extreme inaccessibility. About half is publicly owned. Much of the area has an important value in protecting the watersheds of navigable streams, preventing or reducing soil erosion, protecting wildlife, providing game cover, etc.

[5] Exclusive of that in forest land.

[6] Farmsteads, roads, urban, waste, etc.

[7] Data from forest survey as follows: Missouri, Mississippi, and South Carolina, 1947; Illinois and New Hampshire, 1948; Florida, 1949. Data on crop and pasture lands from 1945 Census of Agriculture.

[8] Includes District of Columbia, 39,000 acres.

[9] Western and central portions of Oklahoma and Texas included in the Plains region; eastern portions included in the west Gulf region.

[10] Eastern and central portions of South Dakota included in the Plains; southwestern portion (Black Hills) included in north Rocky Mountains.

TABLE 2.—*Area of commercial forest of the United States by character of growth, by State and region* [1]

State and region	Total		Saw-timber area [2]			Pole timber area [3]	Seedling and sapling area [4]	Poorly stocked seedling and sapling, and denuded area [5]
			Total	Virgin growth	Second growth			
	Thousand acres	*Percent*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*
New England:								
Connecticut	1,900	0.41	403	----	403	874	390	233
Maine	16,665	3.62	9,339	150	9,189	3,630	2,275	1,421
Massachusetts	3,297	.72	932	2	930	968	874	523
New Hampshire [6]	4,682	1.02	1,808	----	1,808	1,736	512	626
Rhode Island	447	.10	28	----	28	100	255	64
Vermont	3,820	.83	1,604	16	1,588	1,145	600	471
Total	30,811	6.70	14,114	168	13,946	8,453	4,906	3,338
Middle Atlantic:								
Delaware	442	.10	202	2	200	106	89	45
Maryland	2,722	.59	852	4	848	860	635	375
New Jersey	2,329	.51	425	2	423	728	766	410
New York	11,114	2.42	5,376	49	5,327	2,641	1,597	1,500
Pennsylvania	15,127	3.29	3,745	20	3,725	4,892	3,208	3,282
West Virginia	9,852	2.14	4,213	84	4,129	3,487	1,905	247
Total	41,586	9.05	14,813	161	14,652	12,714	8,200	5,859
Lake:								
Michigan	17,380	3.78	2,770	1,125	1,645	3,735	7,075	3,800
Minnesota	16,700	3.64	1,600	260	1,340	2,900	7,200	5,000
Wisconsin	16,265	3.54	2,100	125	1,975	2,870	6,205	5,090
Total	50,345	10.96	6,470	1,510	4,960	9,505	20,480	13,890
Central:								
Illinois [6]	3,941	.86	1,824	----	1,824	983	729	405
Indiana	3,358	.73	1,448	----	1,448	739	747	424
Iowa	2,226	.48	1,168	----	1,168	379	355	324
Kentucky	11,694	2.55	4,218	145	4,073	4,750	1,150	1,576
Missouri [6]	15,074	3.28	2,034	----	2,034	6,481	4,782	1,777
Ohio	4,779	1.04	2,079	----	2,079	1,194	698	808
Total	41,072	8.94	12,771	145	12,626	14,526	8,461	5,314
Plains:								
Kansas	1,011	.22	450	100	350	350	100	111
Nebraska	987	.21	321	75	246	326	160	180
North Dakota	470	.10	110	----	110	80	140	140
Oklahoma (west) [7]	----	----	----	----	----	----	----	----
South Dakota (east) [8]	618	.14	151	25	126	205	105	157
Texas (west) [7]	240	.05	50	----	50	100	40	50
Total	3,326	.72	1,082	200	882	1,061	545	638
Total North	167,140	36.37	49,250	2,184	47,066	46,259	42,592	29,039
South Atlantic:								
North Carolina	17,997	3.92	9,588	----	9,588	2,750	3,834	1,825
South Carolina [6]	11,900	2.59	5,042	----	5,042	3,068	2,901	889
Virginia	14,377	3.13	7,138	----	7,138	3,254	3,208	777
Total	44,274	9.64	21,768	----	21,768	9,072	9,943	3,491
Southeast:								
Alabama	18,800	4.09	10,151	80	10,071	2,383	2,784	3,482
Florida [6]	21,451	4.67	3,233	----	3,233	3,530	2,296	12,392
Georgia	21,107	4.59	11,402	150	11,252	4,273	1,027	4,405
Mississippi [6]	16,509	3.59	5,945	----	5,945	6,406	2,258	1,900
Tennessee	11,850	2.58	6,566	----	6,566	2,372	2,141	771
Total	89,717	19.52	37,297	230	37,067	18,964	10,506	22,950
West Gulf:								
Arkansas	19,928	4.34	12,827	180	12,647	2,877	2,127	2,097
Louisiana	16,169	3.52	10,041	189	9,852	1,502	1,400	3,226
Oklahoma (east) [7]	4,308	.94	2,059	25	2,034	830	297	1,122
Texas (east) [7]	10,548	2.30	7,059	143	6,916	1,049	902	1,538
Total	50,953	11.10	31,986	537	31,449	6,258	4,726	7,983
Total South	184,944	40.26	91,051	767	90,284	34,294	25,175	34,424

See footnotes at end of table, p. 85.

TABLE 2.—*Area of commercial forest of the United States by character of growth, by State and region* [1]—Continued

State and region	Total		Saw-timber area [2]			Pole timber area [3]	Seedling and sapling area [4]	Poorly stocked seedling and sapling, and denuded area [5]
			Total	Virgin growth	Second growth			
	Thousand acres	*Percent*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*
Pacific Northwest:								
Douglas-fir subregion	26,027	5.66	13,158	9,348	3,810	4,394	3,040	5,435
Pine subregion	20,177	4.39	13,140	9,171	3,969	3,107	3,113	815
Total	46,204	10.05	26,298	13,519	7,779	7,501	6,155	6,250
Oregon	26,330	5.73	16,714	11,904	4,810	3,957	2,512	3,147
Washington	19,874	4.32	9,584	6,615	2,969	3,544	3,643	3,103
Total	46,204	10.05	26,298	18,519	7,779	7,501	6,155	6,250
California	16,405	3.57	10,897	8,400	2,497	3,398	53	2,057
North Rocky Mountain:								
Idaho	10,149	2.21	4,766	2,236	2,530	2,255	2,078	1,050
Montana	14,758	3.21	4,948	3,445	1,503	6,638	2,689	483
South Dakota (west) [6]	1,147	.25	629	367	262	259	201	58
Wyoming	3,012	.65	1,648	1,244	404	761	556	47
Total	29,066	6.32	11,991	7,292	4,699	9,913	5,524	1,638
South Rocky Mountain:								
Arizona	2,815	.61	2,569	1,969	600	176	45	25
Colorado	7,874	1.71	3,376	2,324	1,052	2,622	962	914
Nevada	98	.02	40	31	9	56	2	
New Mexico	3,465	.76	2,194	1,834	360	422	450	399
Utah	1,530	.33	1,238	987	251	158	118	16
Total	15,782	3.43	9,417	7,145	2,272	3,434	1,577	1,354
Total West	107,457	23.37	58,603	41,356	17,247	24,246	13,309	11,299
Total all regions	459,541	100.00	198,904	44,307	154,597	104,799	81,076	74,762

[1] Prepared by Forest Service, U. S. Department of Agriculture. Status beginning of 1945 except as footnoted 6. Includes land capable of producing timber of commercial quantity and quality, and available now or prospectively for commercial use.

[2] Includes areas characterized by timber large enough for sawlogs (lumber) regardless of its actual use, and in sufficient volume per acre for economic operation, both in accordance with the practice of the region. Virgin sawtimber includes mature or overmature forests not seriously disturbed by cutting or fire, insect and disease infestations, or other natural causes, and generally characterized by the absence of any net growth; and mature and overmature forests so lightly cut or otherwise disturbed as not to make any material change in the original forest canopy or the quality of the original stand, or to induce net growth in any appreciable amount. Second-growth sawtimber includes forests which have been cut over or which have been so disturbed by fire, insects or disease, windstorms, or other natural causes that net growth occurs and they no longer qualify as virgin forests. Minimum specifications are as follows: New Hampshire, Illinois, Missouri, South Carolina, Florida, and Mississipp: 1,500 board feet per acre in softwood trees 9 inches d. b. h. and larger, and in hardwood trees 11 inches d. b. h. and larger; other States in New England and Middle Atlantic: 2,000 board feet per acre in softwood types 9 inches d. b. h. and larger and 11 inches d. b. h. and larger in hardwoods; Lake and Plains: 2,000 board feet per acre in trees 9 inches d. b. h. and larger; Central: 1,000 board feet per acre in trees 10 inches d. b. h. and larger; South Atlantic, Southeast, West Gulf: at least 600 board feet per acre in trees 9 inches d. b. h. and larger of pine and cypress, and 13 inches and larger of hardwoods; Pacific Northwest (pine subregion), North Rocky Mountain, South Rocky Mountain: In pine type, at least 3,000 board feet per acre in trees 11 inches d. b. h. and larger of pine, cedar, cottonwood, and 13 inches and larger of fir and hemlock; in fir type, 5,000 board feet per acre in trees 11 inches d. b. h. and larger; Pacific Northwest (Douglas-fir subregion): 5,000 board feet per acre in trees 15 inches d. b. h. and larger; California: East side, 4,000 board feet per acre in trees 12 inches d. b. h. and larger; West side, 7,500 board feet per acre in trees 12 inches d. b. h. and larger; redwood, 10,000 board feet per acre in trees 24 inches d. b. h. and larger.

[3] Pole timber areas are characterized by timber too small for sawlog but not large enough for cordwood (5 inches d. b. h. and larger) regardless of whether the stand is cut for this use or held for sawtimber. Timber of polewood size or larger must occupy more than 10 percent of the growing space. For the East generally, a minimum volume of 2 cords per acre was set; does not include noncommercial woodland, even though subject to some cordwood cutting.

[4] Seedling and sapling areas are those on which at least 40 percent of the growing space is occupied by commercial species predominantly below poletimber size and below minimum volume per acre for sawtimber or poletimber.

[5] Poorly stocked seedling and saplings and denuded areas include lands that do not qualify in any previous class.

[6] Data from Forest Survey as follows: Missouri, Mississippi, and South Carolina 1947; Illinois and New Hampshire 1948; Florida 1949.

[7] West and central portions of Oklahoma and Texas included in the Plains region; eastern portions included in the West Gulf region.

[8] Eastern and central portions of South Dakota included in the Plains; southwestern portion (Black Hills) included in North Rocky Mountain region.

TABLE 3.—*Board-foot volume of saw timber on commercial forest land in the United States, by softwoods and hardwoods, and by virgin and second-growth saw timber and other areas: All by State and region* [1]

State and region	Total		Softwoods	Hardwoods	On saw-timber areas		On other than saw-timber areas
					On virgin areas	On second-growth areas	
	Million board feet	*Percent*	*Million board feet*	*Million board feet*	*Million board feet*	*Million board feet*	*Million board feet*
New England:							
Connecticut	1,642	0.10	258	1,384	----	1,111	531
Maine	36,787	2.27	24,279	12,508	525	31,912	4,350
Massachusetts	4,670	.29	1,946	2,724	15	3,867	788
New Hampshire [2]	9,713	.60	5,911	3,802	----	8,125	1,588
Rhode Island	153	.01	22	131	----	69	84
Vermont	7,335	.46	3,334	4,001	98	5,907	1,330
Total	60,300	3.73	35,750	24,550	638	50,991	8,671
Middle Atlantic:							
Delaware	1,183	.07	519	664	25	1,029	129
Maryland	4,030	.25	1,779	2,251	37	3,053	940
New Jersey	2,188	.14	783	1,405	25	1,362	801
New York	25,279	1.56	6,926	18,353	329	21,088	3,862
Pennsylvania	20,582	1.27	3,087	17,495	162	13,406	7,014
West Virginia	8,783	.55	923	7,860	619	7,521	643
Total	62,045	3.84	14,017	48,028	1,197	47,459	13,389
Lake:							
Michigan	24,140	1.49	7,400	16,740	13,550	7,500	3,090
Minnesota	11,590	.72	4,940	6,650	2,020	5,560	4,010
Wisconsin	14,980	.93	3,330	11,650	1,820	10,220	2,940
Total	50,710	3.14	15,670	35,040	17,390	23,280	10,040
Central:							
Illinois [2]	10,346	.64	40	10,306	----	9,125	1,221
Indiana	6,175	.38	6	6,169	----	5,773	402
Iowa	5,344	.33	43	5,301	----	4,842	502
Kentucky	12,392	.77	1,611	10,781	797	10,356	1,239
Missouri [2]	11,898	.74	729	11,169	----	5,776	6,122
Ohio	9,135	.56	73	9,062	----	8,704	431
Total	55,290	3.42	2,502	52,788	797	44,576	9,917
Plains:							
Kansas	2,880	.18	----	2,880	600	1,800	480
Nebraska	1,500	.09	300	1,200	360	660	480
North Dakota	434	.03	20	414	----	344	90
Oklahoma (west) [3]	----	----	----	----	----	----	----
South Dakota (east) [4]	720	.04	96	624	120	480	120
Texas (west) [3]	196	.01	52	144	----	142	54
Total	5,730	.35	468	5,262	1,080	3,426	1,224
Total, north	234,075	14.48	68,407	165,668	21,102	169,732	43,241
South Atlantic:							
North Carolina	42,241	2.61	27,962	14,279	----	40,109	2,132
South Carolina [2]	29,523	1.83	17,560	11,963	----	25,696	3,827
Virginia	25,320	1.57	12,002	13,318	----	21,644	3,676
Total	97,084	6.01	57,524	39,560	----	87,449	9,635
Southeast:							
Alabama	33,361	2.06	20,681	12,680	694	30,482	2,185
Florida [2]	20,594	1.27	15,877	4,717	----	13,517	7,077
Georgia	40,543	2.51	28,941	11,602	2,005	36,121	2,417
Mississippi [2]	29,328	1.81	12,379	16,949	----	23,904	5,424
Tennessee	14,222	.88	2,916	11,306	----	13,254	968
Total	138,048	8.53	80,794	57,254	2,699	117,278	18,071

See footnotes at end of table, p. 87.

TABLE 3.—*Board-foot volume of saw timber on commercial forest land in the United States, by softwoods and hardwoods, and by virgin and second-growth saw timber and other areas: All by State and region* [1]—Continued

State and region	Total		Softwoods	Hardwoods	On saw-timber areas		On other than saw-timber areas
					On virgin areas	On second-growth areas	
	Million board feet	*Percent*	*Million board feet*	*Million board feet*	*Million board feet*	*Million board feet*	*Million board feet*
West Gulf:							
Arkansas	37,528	2.32	22,315	15,213	2,080	33,940	1,508
Louisiana	36,895	2.28	13,930	22,965	2,492	33,184	1,219
Oklahoma (east) [3]	3,048	.19	2,044	1,004	234	2,497	317
Texas (east) [3]	27,488	1.70	19,183	8,305	2,137	24,534	817
Total	104,959	6.49	57,472	47,487	6,943	94,155	3,861
Total, south	340,091	21.03	195,790	144,301	9,642	298,882	31,567
Pacific Northwest:							
Douglas-fir subregion	504,931	31.23	501,065	3,866	408,271	93,811	2,849
Pine subregion	125,963	7.79	125,876	87	104,878	17,895	3,190
Total	630,894	39.02	626,941	3,953	513,149	111,706	6,039
Oregon	381,389	23.59	378,577	2,812	307,288	71,913	2,188
Washington	249,505	15.43	248,364	1,141	205,861	39,793	3,851
Total	630,894	39.02	626,941	3,953	513,149	111,706	6,039
California	227,565	14.07	227,565	----------	180,082	32,624	14,859
North Rocky Mountain:							
Idaho	60,796	3.76	60,764	32	27,078	28,076	5,642
Montana	52,515	3.25	52,112	403	32,020	12,531	7,964
South Dakota (west) [4]	2,866	.18	2,866	----------	1,249	1,333	284
Wyoming	11,052	.68	10,551	501	9,463	1,272	317
Total	127,229	7.87	126,293	936	69,810	43,212	14,207
South Rocky Mountain:							
Arizona	16,270	1.01	16,270	----------	14,265	1,787	218
Colorado	27,658	1.71	26,742	916	18,727	4,860	4,071
Nevada	367	.02	367	----------	287	35	45
New Mexico	8,471	.53	8,471	----------	7,134	871	466
Utah	4,102	.26	4,102	----------	3,627	405	70
Total	56,868	3.53	55,952	916	44,040	7,958	4,870
West	1,042,556	64.49	1,036,751	5,805	807,081	•195,500	39,975
All regions	1,616,722	100.0	1,300,948	315,774	837,825	664,114	114,783

[1] Prepared by Forest Service, U. S. Department of Agriculture. Status beginning of 1945, except as footnoted 2. Includes volume on land capable of producing timber of commercial quantity and quality and available now or prospectively for commercial use. Includes trees large enough for sawlogs regardless of the actual use, in accordance with the practice of the region. Volumes are on lumber-tally basis. Minimum sizes of saw-timber trees: New England, Middle Atlantic: 9 inches D. B. H. for softwoods and 11 inches D. B. H. for hardwoods; Lake, Plains: 9 inches D. B. H.; Central: Illinois and Missouri, 9 inches D. B. H. for softwoods and 11 inches D. B. H. for hardwoods; other States, 10 inches D. B. H.; South Atlantic, Southeast, West Gulf: Florida, South Carolina, and Mississippi, 9 inches D. B. H. for softwoods and 11 inches for hardwoods, other States, 9 inches D. B. H. for pine and cypress and 13 inches for hardwoods; Pacific Northwest (pine subregion), North Rocky Mountain, South Rocky Mountain: In the pine type, 11 inches D. B. H. for pine, cedar, and cottonwood, and 13 inches for fir and hemlock; in the fir type, 11 inches D. B. H.; Pacific Northwest (Douglas-fir subregion): 15 inches D. B. H.; California: All except redwood type, 12 inches D. B. H.; redwood type, 24 inches D. B. H. Virgin growth includes mature or overmature forests not seriously disturbed by cutting or by fire, insects, and disease infestations, or other natural causes, and generally characterized by the absence of any net growth; and mature or overmature forests so lightly cut or otherwise disturbed as not to make any material change in the original forest canopy or the quality of the original stand, or to induce net growth in any appreciable amount. Second growth includes forests which have been cut over or which have been so disturbed by fire, insects, or disease, windstorms, or other natural causes that net growth occurs and they no longer qualify as virgin forests.

[2] Data from Forest Survey as follows: Missouri, Mississippi, and South Carolina, 1947; Illinois and New Hampshire, 1948; Florida, 1949.

[3] Volume in western and central portions of Oklahoma and Texas included in the Plains region; that in eastern portions included in the west Gulf region.

[4] Volume in eastern and central portions of South Dakota included in the Plains; that in southwestern portion (Black Hills) included in North Rocky Mountain region.

TABLE 4.—*Cubic-foot volume of softwoods and hardwoods on commercial forest land in the United States, by size of trees and by State and region* [1]

State and region	All timber				Saw-timber trees [2]			Pole-timber trees [2]		
	Total		Softwood	Hardwood	Total	Softwood	Hardwood	Total	Softwood	Hardwood
	Million cubic feet	*Percent*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*
New England:										
Connecticut	967	0.21	121	846	448	52	396	519	69	450
Maine	15,046	3.21	7,803	7,243	8,237	4,856	3,381	6,809	2,947	3,862
Massachusetts	2,194	.47	661	1,533	1,105	388	717	1,089	273	816
New Hampshire [4]	3,823	.82	1,892	1,931	2,009	1,194	815	1,814	698	1,116
Rhode Island	120	.02	17	103	42	4	38	78	13	65
Vermont	2,921	.62	1,291	1,630	1,667	667	1,000	1,254	624	630
Total	25,071	5.35	11,785	13,286	13,508	7,161	6,347	11,563	4,624	6,939
Middle Atlantic:										
Delaware	441	.09	167	274	270	104	166	171	63	108
Maryland	1,859	.40	690	1,169	933	356	577	926	334	592
New Jersey	1,210	.26	370	840	526	157	369	684	213	471
New York	9,668	2.06	2,533	7,135	5,861	1,385	4,476	3,807	1,148	2,659
Pennsylvania	9,570	2.04	1,161	8,409	5,346	617	4,729	4,224	544	3,680
West Virginia	4,611	.98	455	4,156	2,295	212	2,083	2,316	243	2,073
Total	27,359	5.83	5,376	21,983	15,231	2,831	12,400	12,128	2,545	9,583
Lake:										
Michigan	10,300	2.20	3,300	7,000	6,500	2,000	4,500	3,800	1,300	2,500
Minnesota	5,900	1.26	2,400	3,500	3,100	1,300	1,800	2,800	1,100	1,700
Wisconsin	7,000	1.49	1,300	5,700	4,100	900	3,200	2,900	400	2,500
Total	23,200	4.95	7,000	16,200	13,700	4,200	9,500	9,500	2,800	6,700
Central:										
Illinois [4]	3,511	.75	12	3,499	2,704	10	2,694	807	2	805
Indiana	1,919	.41	4	1,915	1,522	2	1,520	397	2	395
Iowa	1,904	.41	14	1,890	1,384	10	1,374	520	4	516
Kentucky	6,826	1.45	850	5,976	3,004	353	2,651	3,822	497	3,325
Missouri [4]	5,765	1.23	289	5,476	3,431	162	3,269	2,334	127	2,207
Ohio	2,890	.61	40	2,850	2,287	16	2,271	603	24	579
Total	22,815	4.86	1,209	21,606	14,332	553	13,779	8,483	656	7,827

Plains:										
Kansas	1,391	.30		1,391	480		480	911		911
Nebraska	1,078	.23	157	921	250	50	200	828	107	721
North Dakota	465	.10	15	450	110	5	105	355	10	345
Oklahoma (West)[5]										
South Dakota (East)[6]	630	.13	60	570	180	24	156	450	36	414
Texas (West)[5]	159	.03	37	122	47	11	36	112	26	86
Total	3,723	.79	269	3,454	1,067	90	977	2,656	179	2,477
Total, North	102,168	21.78	25,639	76,529	57,838	14,835	43,003	44,330	10,804	33,526
South Atlantic:										
North Carolina	14,729	3.14	7,665	7,064	9,417	5,799	3,618	5,312	1,866	3,446
South Carolina [4]	9,142	1.95	4,806	4,336	6,322	3,515	2,807	2,820	1,291	1,529
Virginia	11,551	2.46	4,321	7,230	6,243	2,683	3,560	5,308	1,638	3,670
Total	35,422	7.55	16,792	18,630	21,982	11,997	9,985	13,440	4,795	8,645
Southeast:										
Alabama	13,620	2.90	6,821	6,799	7,412	4,167	3,245	6,208	2,654	3,554
Florida [4]	7,357	1.57	5,374	1,983	4,273	3,279	994	3,084	2,095	989
Georgia	15,237	3.25	8,473	6,764	8,915	5,879	3,036	6,322	2,594	3,728
Mississippi [4]	9,251	1.97	3,331	5,920	6,746	2,519	4,227	2,505	812	1,693
Tennessee	5,993	1.28	873	5,120	3,661	682	2,979	2,332	191	2,141
Total	51,458	10.97	24,872	26,586	31,007	16,526	14,481	20,451	8,346	12,105
West Gulf:										
Arkansas	15,187	3.24	7,018	8,169	8,342	4,498	3,844	6,845	2,520	4,325
Louisiana	13,933	2.97	3,761	10,172	8,670	2,734	5,936	5,263	1,027	4,236
Oklahoma (East) [5]	1,303	.28	612	691	655	409	246	648	203	445
Texas (East) [5]	10,266	2.19	6,069	4,197	5,957	3,866	2,091	4,309	2,203	2,106
Total	40,689	8.68	17,460	23,229	23,624	11,507	12,117	17,065	5,953	11,112
Total, South	127,569	27.20	59,124	68,445	76,613	40,030	36,583	50,956	19,094	31,862
Pacific Northwest:										
Douglas-fir subregion	117,222	25.00	115,499	1,723	90,603	89,926	677	26,619	25,573	1,046
Pine subregion	28,657	6.11	28,623	34	21,976	21,960	16	6,681	6,663	18
Total	145,879	31.11	144,122	1,757	112,579	111,886	693	33,300	32,236	1,064
Oregon	85,213	18.17	84,004	1,209	68,296	67,805	491	16,917	16,199	718
Washington	60,666	12.94	60,118	548	44,283	44,081	202	16,383	16,037	346
Total	145,879	31.11	144,122	1,757	112,579	111,886	693	33,300	32,236	1,064
California	44,600	9.51	44,600		41,250	41,250		3,350	3,350	

See footnotes at end of table, p. 90.

TABLE 4.—*Cubic-foot volume of softwoods and hardwoods on commercial forest land in the United States, by size of trees and by State and region* [1]—Continued

State and region	All timber				Saw-timber trees [2]			Pole-timber trees [3]		
	Total		Softwood	Hardwood	Total	Softwood	Hardwood	Total	Softwood	Hardwood
	Million cubic feet	*Percent*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*
North Rocky Mountain:										
Idaho	14,024	2.99	14,015	9	9,969	9,962	7	4,055	4,053	2
Montana	14,137	3.01	13,937	200	8,241	8,149	92	5,896	5,788	108
South Dakota (west)[6]	868	.19	868		574	574		294	294	
Wyoming	4,321	.92	4,106	215	2,271	2,171	100	2,050	1,935	115
Total	33,350	7.11	32,926	424	21,055	20,856	199	12,295	12,070	225
South Rocky Mountain:										
Arizona	2,924	.62	2,924		2,456	2,456		468	468	
Colorado	9,617	2.05	8,750	867	5,873	5,687	186	3,744	3,063	681
Nevada	100	.02	100		64	64		36	36	
New Mexico	1,705	.36	1,705		1,284	1,284		421	421	
Utah	1,096	.24	1,096		821	821		275	275	
Total	15,442	3.29	14,575	867	10,498	10,312	186	4,944	4,263	681
Total West	239,271	51.02	236,223	3,048	185,382	184,304	1,078	53,889	51,919	1,970
Total, all regions	469,008	100.00	320,986	148,022	319,833	239,169	80,664	149,175	81,817	67,358

[1] Prepared by Forest Service, U. S. Department of Agriculture. Status beginning of 1945, except as footnoted 4. Volume does not include bark. Includes volume on land capable of producing timber of commercial quantity and quality and available now or prospectively for commercial use.

[2] Includes tops and limbs (tops only in softwoods) as well as portion of tree suitable for sawlogs. Minimum sizes of sawtimber trees: New England, Middle Atlantic: 9 inches D. B. H. in softwoods and 11 inches for hardwoods; Lake, Plains: 9 inches D. B. H.; Central: 10 inches D. B. H. (1) except in Illinois and Missouri with 9 inches for softwoods and 11 inches for hardwoods; South Atlantic, Southeast, West Gulf: 9 inches D. B. H. for pine and 13 inches for hardwoods (2) except in Florida, South Carolina, and Mississippi with 9 inches for softwoods and 11 inches for hardwoods; Pacific Northwest (pine subregion), North Rocky Mountain: in pine type 11 inches D. B. H. for pine, cedar, and cottonwood, and 13 inches for fir and hemlock; in the fir type, 11 inches D. B. H.; Pacific Northwest (Douglas-fir subregion) 15 inches D. B. H.; California: all except redwood type 12 inches D. B. H.; redwood type 24 inches D. B. H.

[3] Includes trees between 5 inches D. B. H. and minimum sawtimber size.

[4] Data from Forest Survey as follows: Missouri, Mississippi, and South Carolina 1947; Illinois and New Hampshire 1948; Florida 1949.

[5] Volume in western and central portions of Oklahoma and Texas, included in plains region; volume in eastern portions included in the West Gulf region.

[6] Volumes in the eastern and central portions of South Dakota included in the plains; volume in the southwestern portion (Black Hills) included in North Rocky Mountain region.

C-SUPERVISION
Reappraisal Project

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TABLE 5.—*Ownership of commercial forest land of the United States, by State and region, all areas* [1]

State and region	All ownerships	Federally owned or managed			State, county, and municipal	Private
		Total	National forest	Other		
	Thousand acres	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*
New England:						
Connecticut	1,900				155	1,745
Maine	16,665	74	47	27	50	16,541
Massachusetts	3,297	24	1	23	271	3,002
New Hampshire [2]	4,682	585	580	5	97	4,000
Rhode Island	447				27	420
Vermont	3,820	172	161	11	84	3,564
Total	30,811	855	789	66	684	29,272
Middle Atlantic:						
Delaware	442	2		2	7	433
Maryland	2,722	44	3	41	149	2,529
New Jersey	2,329	53		53	96	2,180
New York	11,114	75		75	732	10,307
Pennsylvania	15,127	470	442	28	2,514	12,143
West Virginia	9,852	832	820	12	115	8,905
Total	41,586	1,476	1,265	211	3,613	36,497
Lake:						
Michigan	17,380	2,155	2,035	120	4,115	11,110
Minnesota	16,700	2,670	2,170	500	7,100	6,930
Wisconsin	16,265	1,670	1,250	420	3,590	11,005
Total	50,345	6,495	5,455	1,040	14,805	29,045
Central:						
Illinois [2]	3,941	179	147	32	10	3,752
Indiana	3,358	104	79	25	76	3,178
Iowa	2,226	16	5	11	19	2,191
Kentucky	11,694	534	427	107	35	11,125
Missouri [2]	15,074	1,318	1,197	121	120	13,636
Ohio	4,779	72	72		108	4,599
Total	41,072	2,223	1,927	296	368	38,481
Plains:						
Kansas	1,011					1,011
Nebraska	987	39	15	24		948
North Dakota	470	55		55	1	414
Oklahoma (West) [3]						
South Dakota (East) [4]	618	215	15	200	3	400
Texas (West) [3]	240	23		23		217
Total	3,326	332	30	302	4	2,990
Total, North	167,140	11,381	9,466	1,915	19,474	136,285
South Atlantic:						
North Carolina	17,997	1,312	960	352	242	16,443
South Carolina [2]	11,900	660	516	144	194	11,046
Virginia	14,377	1,453	1,266	187	107	12,817
Total	44,274	3,425	2,742	683	543	40,306
Southeast:						
Alabama	18,800	886	613	273	121	17,793
Florida [2]	21,451	1,981	1,025	956	279	19,191
Georgia	21,107	1,202	646	556	72	19,833
Mississippi [3]	16,500	1,225	1,035	190	499	14,785
Tennessee	11,850	801	555	246	287	10,762
Total	89,717	6,095	3,874	2,221	1,258	82,364

See footnotes at end of table, p. 92.

TABLE 5.—*Ownership of commercial forest land of the United States, by State and region, all areas* [1]—Continued

State and region	All ownerships	Federally owned or managed			State, county, and municipal	Private
		Total	National forest	Other		
	Thousand acres	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acre*
West Gulf:						
Arkansas	19,928	2,645	2,214	431	104	17,179
Louisiana	16,169	747	536	211	265	15,157
Oklahoma (East) [3]	4,308	619	163	456	23	3,666
Texas (East) [3]	10,548	673	648	25	16	9,859
Total	50,953	4,684	3,561	1,123	408	45,861
Total, South	184,944	14,204	10,177	4,027	2,209	168,531
Pacific Northwest:						
Douglas-fir subregion	26,027	10,201	7,682	2,519	2,616	13,210
Pine subregion	20,177	12,811	9,659	3,152	819	6,547
Total	46,204	23,012	17,341	5,671	3,435	19,757
Oregon	26,330	15,251	11,530	3,721	1,101	9,978
Washington	19,874	7,761	5,811	1,950	2,334	9,779
Total	46,204	23,012	17,341	5,671	3,435	19,757
California	16,405	8,099	7,684	415	23	8,283
North Rocky Mountain:						
Idaho	10,149	6,436	5,838	598	925	2,788
Montana	14,758	10,122	9,118	1,004	699	3,937
South Dakota (West) [4]	1,147	920	918	2	4	223
Wyoming	3,012	2,534	2,187	347	74	404
Total	29,066	20,012	18,061	1,951	1,702	7,352
South Rocky Mountain:						
Arizona	2,815	2,744	2,058	686	30	41
Colorado	7,874	5,923	5,387	536	152	1,799
Nevada	98	24	24			74
New Mexico	3,465	2,405	2,020	385	149	911
Utah	1,530	1,349	1,276	73	49	132
Total	15,782	12,445	10,765	1,680	380	2,957
Total West	107,457	63,568	53,851	9,717	5,540	38,349
Total all regions	459,541	89,153	73,494	15,659	27,223	343,165

[1] Prepared by Forest Service, U. S. Department of Agriculture. Includes land capable of producing timber of commercial quantity and quality, and available now or prospectively, for commercial use. Status beginning of 1945 except as footnoted 2.

[2] Data from Forest Survey as follows: Missouri, Mississippi, and South Carolina, 1947; Illinois and New Hampshire, 1948; Florida, 1949.

[3] Western and central portions of Oklahoma and Texas included in the Plains region; eastern portions included in the West Gulf region.

[4] Eastern and central portions of South Dakota included in the Plains; southwestern portion (Black Hills) included in the North Rocky Mountain region.

TABLE 6.—*Ownership of saw timber on commercial forest land of the United States, by State and region* [1]

State and region	All ownerships	Federally owned or managed			State, county and municipal	Private
		Total	National forest	Other		
	Million board feet	*Million board feet*	*Million board feet*	*Million board feet*	*Million board feet*	*Million board feet*
New England:						
Connecticut	1,642			1	145	1,497
Maine	36,787	155	91	64	116	36,516
Massachusetts	4,670	27	1	26	316	4,327
New Hampshire [2]	9,713	1,614	1,607	7	114	7,985
Rhode Island	153				8	145
Vermont	7,335	519	497	22	194	6,622
Total	60,300	2,315	2,196	119	893	57,092
Middle Atlantic:						
Delaware	1,183	1			18	1,164
Maryland	4,030	44	5	39	182	3,804
New Jersey	2,188	31		31	84	2,073
New York	25,279	102		102	1,071	24,106
Pennsylvania	20,582	460	433	27	2,420	17,702
West Virginia	8,783	1,225	1,214	11	102	7,456
Total	62,045	1,863	1,652	211	3,877	56,305
Lake:						
Michigan	24,140	430	405	25	660	23,050
Minnesota	11,590	2,890	2,600	290	3,770	4,930
Wisconsin	14,980	980	280	700	910	13,090
Total	50,710	4,300	3,285	1,015	5,340	41,070
Central:						
Illinois [2]	10,346	423	339	84	27	9,896
Indiana	6,175	65	18	47	143	5,967
Iowa	5,344	28	2	26	46	5,270
Kentucky	12,392	786	689	97	44	11,562
Missouri [2]	11,898	1,058	975	83	98	10,742
Ohio	9,135	90	90		277	8,768
Total	55,290	2,450	2,113	337	635	52,205
Plains:						
Kansas	2,880					2,880
Nebraska	1,500	3		3		1,497
North Dakota	434	28		28		406
Oklahoma (west) [3]						
South Dakota (east) [4]	720	97	3	94	1	622
Texas (west) [3]	196	10		10		186
Total	5,730	138	3	135	1	5,591
Total, North	234,075	11,066	9,249	1,817	10,746	212,263
South Atlantic:						
North Carolina	42,241	2,724	1,844	880	640	38,877
South Carolina [2]	29,523	1,696	1,378	318	345	27,482
Virginia	25,320	1,769	1,359	410	240	23,311
Total	97,084	6,189	4,581	1,608	1,225	89,670
Southeast:						
Alabama	33,361	1,182	929	253	55	32,124
Florida [2]	20,594	2,291	1,331	960	240	18,063
Georgia	40,543	1,784	1,282	502	48	38,711
Mississippi [2]	29,328	3,176	2,603	573	945	25,207
Tennessee	14,222	912	618	294	154	13,156
Total	138,048	9,345	6,763	2,582	1,442	127,261

See footnotes at end of table, p. 94.

TABLE 6.—*Ownership of saw timber on commercial forest land of the United States, by State and region*—Continued

State and region	All ownerships	Federally owned or managed			State, county and municipal	Private
		Total	National forest	Other		
	Million board feet	*Million board feet*	*Million board feet*	*Million board feet*	*Million board feet*	*Million board feet*
West Gulf:						
Arkansas	37,528	3,487	3,009	478	47	33,994
Louisiana	36,895	589	500	89	725	35,581
Oklahoma (east) [3]	3,048	145	24	121	41	2,862
Texas (east) [3]	27,488	1,354	1,340	14	34	26,100
Total	104,959	5,575	4,873	702	847	98,537
Total, South	340,091	21,109	16,217	4,892	3,514	315,468
Pacific Northwest:						
Douglas-fir subregion	504,931	265,641	208,384	57,257	35,354	203,936
Pine subregion	125,963	92,860	70,177	22,683	3,856	29,247
Total	630,894	358,501	278,561	79,940	39,210	233,183
Oregon	381,389	243,552	179,096	64,456	7,452	130,385
Washington	249,505	114,949	99,465	15,484	31,758	102,798
Total	630,894	358,501	278,561	79,940	39,210	233,183
California	227,565	104,192	99,770	4,422	157	123,216
North Rocky Mountain:						
Idaho	60,796	32,821	30,601	2,220	7,721	20,254
Montana	52,515	35,057	31,688	3,369	2,946	14,512
South Dakota (West) [4]	2,866	2,467	2,466	1	8	391
Wyoming	11,052	10,196	8,886	1,310	153	703
Total	127,229	80,541	73,641	6,900	10,828	35,860
South Rocky Mountain:						
Arizona	16,270	16,017	11,550	4,467	105	148
Colorado	27,658	24,841	23,566	1,275	319	2,498
Nevada	367	89	89			278
New Mexico	8,471	6,405	5,610	795	407	1,659
Utah	4,102	3,831	3,716	115	123	148
Total	56,868	51,183	44,531	6,652	954	4,731
Total, West	1,042,556	594,417	496,503	97,914	51,149	396,990
Total, all regions	1,616,722	626,592	521,969	104,623	65,409	924,721

[1] Prepared by Forest Service, U. S. Department of Agriculture. Status beginning of 1945 except as footnoted 2. Includes trees large enough for sawlogs in accordance with the practice of the region regardless of the actual use. Volumes are on lumber-tally basis. This volume occurs on land capable of producing timber of commercial quantity and quality and available or prospectively for commercial use. Minimum sizes of saw-timber trees: New England, Middle Atlantic: 9 inches diameter at breast height for softwood and 11 inches for hardwood; Lake, Plains: 9 inches diameter at breast height; Central: 10 inches diameter at breast height except in Illinois and Missouri with 9 inches for softwood and 11 inches for hardwood; South Atlantic, Southeast, West Gulf: 9 inches diameter at breast height for pine and cypress and 13 inches for hardwoods except in Florida, South Carolina, and Mississippi with 9 inches for softwoods and 11 inches for hardwoods; Pacific Northwest (pine subregion) North Rocky Mountain, and South Rocky Mountain: in the pine type, 11 inches diameter at breast height, for pine, cedar and cottonwood, and 13 inches for fir and hemlock: in the fir type, 11 inches diameter at breast height; Pacific Northwest (Douglas-fir subregion) 15 inches diameter at breast height; California: all except redwood type 12 inches diameter at breast height; redwood type 24 inches diameter at breast height.

[2] Data from Forest Survey as follows: Missouri, Mississippi and South Carolina 1947; Illinois and New Hampshire 1948; Florida 1949.

[3] Volumes in western and central portions of Oklahoma and Texas included in the Plains region; those in the eastern portions included in the West Gulf region.

[4] Volumes in eastern and central portions of South Dakota included in the Plains; those in the southwestern portion (Black Hills) included in North Rocky Mountain region.

TABLE 7.—*Current annual growth of all timber and of sawtimber on commercial forest land in the United States, by State and region* [1]

State and region	All timber growth [2]			Sawtimber growth [2]		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood
	Million cubic feet	*Million cubic feet*	*Million cubic feet*	*Million board feet*	*Million board feet*	*Million board feet*
New England:						
Connecticut	55	6	49	107	14	93
Maine	397	252	145	760	491	269
Massachusetts	123	32	91	242	96	146
New Hampshire	182	73	109	380	174	215
Rhode Island	6	1	5	9	1	8
Vermont	134	55	79	292	134	158
Total	897	419	478	1,799	910	889
Middle Atlantic:						
Delaware	29	11	18	62	27	35
Maryland	104	52	52	202	105	97
New Jersey	65	25	40	103	37	66
New York	392	84	308	785	191	594
Pennsylvania	566	75	491	1,111	193	918
West Virginia	241	26	215	449	44	405
Total	1,397	273	1,124	2,712	597	2,115
Lake:						
Michigan	295	48	247	519	96	423
Minnesota	302	101	201	420	176	244
Wisconsin	215	29	186	464	74	390
otal	812	178	634	1,403	346	1,057
Central:						
Illinois	104	----------	104	208	1	207
Indiana	137	1	136	298	2	296
Iowa	121	1	120	295	2	293
Kentucky	475	59	416	638	83	555
Missouri	341	32	309	388	37	351
Ohio	262	2	260	421	3	418
Total	1,440	95	1,345	2,248	128	2,120
Plains:						
Kansas	51	----------	51	82	----------	82
Nebraska	36	6	30	58	10	48
North Dakota	10	1	9	16	1	15
Oklahoma (west) [4]	----------	----------	----------	----------	----------	----------
South Dakota (east) [4]	17	2	15	26	4	22
Texas (west) [4]	6	2	4	11	4	7
Total	120	11	109	193	19	174
Total, North	4,666	976	3,690	8,355	2,000	6,355
South Atlantic:						
North Carolina	721	438	283	2,589	1,835	754
South Carolina	454	284	170	1,733	1,234	499
Virginia	586	285	301	1,784	947	837
Total	1,761	1,007	754	6,106	4,016	2,090
Southeast:						
Alabama	750	452	298	2,021	1,392	629
Florida	310	202	108	989	767	222
Georgia	740	507	233	2,501	1,995	506
Mississippi	667	264	403	1,866	904	962
Tennessee	247	55	192	847	226	621
Total	2,714	1,480	1,234	8,224	5,284	2,940

See footnotes at end of table, p. 96.

TABLE 7.—*Current annual growth of all timber and of sawtimber on commercial forest land in the United States, by State and region* [1]—Continued

State and region	All timber growth [2]			Sawtimber growth [3]		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood
	Million cubic feet	*Million cubic feet*	*Million cubic feet*	*Million board feet*	*Million board feet*	*Million board feet*
West Gulf:						
Arkansas	670	338	332	1,929	1,186	743
Louisiana	631	244	387	1,893	970	923
Oklahoma (east) [4]	55	27	28	137	95	42
Texas (east) [4]	560	424	136	1,649	1,368	281
Total	1,916	1,033	883	5,608	3,619	1,989
Total, South	6,391	3,520	2,871	19,938	12,919	7,019
Pacific Northwest:						
Douglas-fir subregion	1,024	992	32	3,741	3,669	72
Pine subregion	219	219	----------	483	483	----------
Total	1,243	1,211	32	4,224	4,152	72
Oregon	659	640	19	2,483	2,432	51
Washington	584	571	13	1,741	1,720	21
Total	1,243	1,211	32	4,224	4,152	72
California	335	335	----------	1,160	1,160	----------
North Rocky Mountain:						
Idaho	302	302	[6]	826	826	[7]
Montana	162	159	3	418	414	4
South Dakota (West) [5]	12	12	[6]	22	22	[7]
Wyoming	64	64	[6]	40	40	[7]
Total	540	537	3	1,306	1,302	4
South Rocky Mountain:						
Arizona	30	30	----------	94	94	----------
Colorado	130	112	18	145	142	3
Nevada	1	1	----------	1	1	----------
New Mexico	23	23	----------	58	58	----------
Utah	11	11	----------	20	20	----------
Total	195	177	18	318	315	3
Total West	2,313	2,260	53	7,008	6,929	79
Total all regions	13,370	6,756	6,614	35,301	21,848	13,453

[1] Prepared by Forest Service, U. S. Department of Agriculture. Status beginning of 1945. Includes growth on land capable of producing timber of commercial quantity and quality and available now or prospectively for commercial use.

[2] Annual growth of all trees 5 inches diameter at breast height and larger, including tops and limbs (top only in softwoods) of saw timber trees and total volume of trees reaching 5 inches in diameter at breast height each year. Bark not included.

[3] Annual growth on the trees above the following minimum saw timber sizes and total volume of trees reaching these minimum sizes each year, all on lumber-tally basis: New England, Middle Atlantic: 9 inches diameter at breast height for softwoods and 11 inches for hardwoods; Lake, Plains: 9 inches diameter at breast height; Central: 10 inches diameter at breast height; SouthAtlantic, Southeast, West Gulf: 9 inches diameter at breast height for pine and cypress and 13 inches for hardwoods; Pacific Northwest (pine subregion), North Rocky Mountain, South Rocky Mountain: in the pine type, 11 inches diameter at breast height for pine, cedar, and cottonwood, and 13 inches for fir and hemlock; in the fir type, 11 inches diameter at breast height; Pacific Northwest (Douglas-fir subregion): 15 inches diameter at breast height; California: all except redwood type 12 inches diameter at breast height; redwood type 24 inches diameter at breast height.

[4] Growth in western and central portions of Oklahoma and Texas included in the Plains regions; that in eastern portions included in the west Gulf region.

[5] Growth in eastern and central portions of South Dakota included in the Plains; that in the southwestern portion (Black Hills) included in north Rocky Mountain region.

[6] Less than 500,000 cubic feet.

[7] Less than 500,000 board feet.

TABLE 8.—*Annual drain from all timber and from saw timber on commercial forest lands of the United States by regions* [1]

Region	All timber [2]			Saw timber [3]		
	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods
	Million cubic feet	*Million cubic feet*	*Million cubic feet*	*Million board feet*	*Million board feet*	*Million board feet*
New England	761	375	386	2,204	1,438	766
Middle Atlantic	846	180	666	2,304	582	1,722
Lake	747	323	424	2,006	839	1,167
Central	1,201	49	1,152	2,342	120	2,222
Plains	118	7	111	176	11	165
Total, North	3,673	934	2,739	9,032	2,990	6,042
South Atlantic	1,596	1,063	533	6,144	4,301	1,843
Southeast	3,023	1,789	1,234	11,924	7,538	4,386
West Gulf	1,842	851	991	6,831	3,798	3,033
Total, South	6,461	3,703	2,758	24,899	15,637	9,262
Pacific Northwest:						
Douglas-fir subregion	2,150	2,145	5	12,006	11,981	25
Pine subregion	468	468		2,526	2,526	
Total	2,618	2,613	5	14,532	14,507	25
California	489	489		3,158	3,158	
North Rocky Mountain	316	310	6	1,792	1,763	29
South Rocky Mountain	104	102	2	480	475	5
Total West	3,527	3,514	13	19,962	19,903	59
Total all regions	13,661	8,151	5,510	53,893	38,530	15,363

[1] Prepared by Forest Service, U. S. Department of Agriculture. Includes timber cut for commodities, 1944, and timber removed by destructive agencies (fire, insects, disease, wind, etc.), the latter an average for the 10-year period 1934–43. This drain comes from land capable of producing timber of commercial quantity and quality and available now or prospectively for commercial use.

[2] Annual drain of all trees 5 inches in diameter at breast height and larger, including tops and limbs (tops only in softwoods) of saw timber trees and total volume of trees reaching 5 inches in diameter at breast height each year. Bark not included.

[3] Annual drain on trees above the following minimum saw timber sizes and total volume of trees reaching these minimum sizes each year. All on lumber-tally basis: New England, Middle Atlantic—9 inches in diameter at breast height for softwoods and 11 inches for hardwoods; Lake, Plains—9 inches in diameter at breast height; Central—10 inches in diamenter at breast height; South Atlantic, Southeast, West Gulf—9 inches in diameter at breast height for pine and cypress, and 13 inches for hardwoods; Pacific Northwest (pine subregion), North Rocky Mountain, South Rocky Mountain—in the pine type, 11 inches in diameter at breast height for pine, cedar, and cottonwood, and 13 inches for fir and hemlock; in the fir type, 11 inches in diameter at breast height; Pacific Northwest (Douglas-fir subregion)—15 inches in diameter at breast height; California—All except redwood type, 12 inches in diameter at breast height; redwood type, 24 inches in diameter at breast height.

TABLE 9.—*Annual drain from all timber and from saw timber on commercial forest land of the United States by cutting for commodities and by destructive agencies* [1]

TIMBER CUT FOR COMMODITIES

Item	All timber drain [2]			Saw timber drain [3]		
	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods
	Million cubic feet	*Million cubic feet*	*Million cubic feet*	*Million board feet*	*Million board feet*	*Million board feet*
Lumber	6,711	4,778	1,933	34,391	26,130	8,261
Fuel wood	2,203	719	1,484	3,863	1,957	1,906
Pulpwood	1,306	1,163	143	4,757	4,500	257
Hewed ties	363	153	210	1,643	777	866
Fence posts	220	59	161	226	82	144
Veneer logs	392	165	227	1,971	942	1,029
Mine timbers	225	40	185	320	70	250
Cooperage	174	40	134	744	195	549
Shingles	72	72		334	334	
Other	516	159	357	1,409	604	805
Total	12,182	7,348	4,834	49,658	35,391	14,067

TIMBER REMOVED BY DESTRUCTIVE AGENCIES

Fire	460	247	213	859	547	312
Insects, disease, wind, etc.	1,019	556	463	3,376	2,392	984
Total	1,479	803	676	4,235	2,939	1,296
Aggregate	13,661	8,151	5,510	53,893	38,530	15,363

[1] Prepared by Forest Service, U. S. Department of Agriculture. Commodity drain for 1944; drain by destructive agencies, average for the 10-year period 1934–43. Includes drain in volume from land capable of producing timber of commercial quantity and quality and available now or prospectively for commercial use.

[2] Drain from all trees 5 inches d. b. h. and larger, bark not included.

[3] Drain (lumber-tally basis) from trees above the following minimum saw-timber sizes:
New England, Middle Atlantic: 9 inches d. b. h. for softwoods and 11 inches for hardwoods.
Lake, Plains: 9 inches d. b. h.
Central: 10 inches d. b. h.
South Atlantic, Southeast, West Gulf: 9 inches d. b. h. for pine and cypress, and 13 inches for hardwoods.
Pacific Northwest (pine subregion), North Rocky Mountain, South Rocky Mountain: In the pine type, 11 inches d. b. h. for pine, cedar, and cottonwood, and 13 inches for fir and hemlock; in the fir type, 11 inches d. b. h.
Pacific Northwest (Douglas-fir subregion), 15 inches d. b. h.
California: All except redwood type, 12 inches d. b. h.; redwood type, 24 inches d. b. h.

TABLE 10.—*Volume of saw timber in the United States by species and by State and region* [1]

EASTERN SOFTWOODS

[Million board feet]

State and region	Total	Southern yellow pine	Spruce and fir [2]	White and Norway pine	Hemlock	Cypress	Others
New England:							
Connecticut	258	2	1	93	160	----	2
Maine	24,279	----	16,554	4,091	2,362	----	1,272
Massachusetts	1,946	117	136	993	681	----	19
New Hampshire [3]	5,911	103	1,343	3,241	1,186	----	38
Rhode Island	22	----	----	21	1	----	----
Vermont	3,334	----	2,056	800	408	----	70
Total	35,750	222	20,090	9,239	4,798	----	1,401
Middle Atlantic:							
Delaware	519	518	----	----	----	----	1
Maryland	1,779	1,729	1	14	20	----	15
New Jersey	783	666	----	23	39	----	55
New York	6,926	52	2,441	1,700	2,595	----	138
Pennsylvania	3,087	947	21	1,234	885	----	----
West Virginia	923	123	255	79	457	----	9
Total	14,017	4,035	2,718	3,050	3,996	----	218
Lake:							
Michigan	7,400	----	1,510	1,090	4,560	----	240
Minnesota	4,940	----	1,690	1,370	----	----	1,880
Wisconsin	3,330	----	400	1,230	1,390	----	310
Total	15,670	----	3,600	3,690	5,950	----	2,430
Central:							
Illinois [3]	40	----	----	----	----	[4] 40	----
Indiana	6	3	----	1	----	1	1
Iowa	43	----	----	6	----	----	37
Kentucky	1,611	1,078	----	149	335	37	12
Missouri [3]	729	483	----	----	----	194	52
Ohio	73	60	----	3	8	----	2
Total	2,502	1,624	----	159	343	272	104
Plains:							
Kansas	----	----	----	----	----	----	----
Nebraska	300	----	----	----	----	----	[5] 300
North Dakota	20	----	----	----	----	----	[5] 20
Oklahoma (west)	----	----	----	----	----	----	----
South Dakota (east)	96	----	----	----	----	----	[5] 96
Texas (west)	52	51	----	----	----	1	----
Total	468	51	----	----	----	1	[5] 416
Total North	68,407	5,932	26,408	16,138	15,087	273	4,569
South Atlantic:							
North Carolina	27,962	25,761	40	397	430	969	365
South Carolina [3]	17,560	16,188	----	16	33	1,292	31
Virginia	12,002	11,042	----	407	245	202	106
Total	57,524	52,991	40	820	708	2,463	502
Southeast:							
Alabama	20,681	20,250	----	----	----	209	222
Florida [3]	15,877	12,691	----	----	----	3,095	91
Georgia	28,941	27,120	----	136	----	570	1,115
Mississippi [3]	12,379	11,563	----	----	----	802	14
Tennessee	2,916	2,078	----	199	142	241	256
Total	80,794	73,702	----	335	142	4,917	1,698
West Gulf:							
Arkansas	22,315	22,308	----	----	----	----	7
Louisiana	13,930	12,981	----	----	----	547	402
Oklahoma (east)	2,044	2,038	----	----	----	1	5
Texas (east)	19,183	19,164	----	----	----	----	19
Total	57,472	56,491	----	----	----	548	433
Total South	195,790	183,184	40	1,155	850	7,928	2,633
All North and South	264,197	189,116	26,448	17,293	15,937	8,201	7,202

[1] Prepared by Forest Service, U. S. Department of Agriculture. Status beginning of 1945, except for States footnoted 3.

[2] Balsam fir.

[3] Data from Forest Survey as follows: Missouri, Mississippi, and South Carolina, 1947; Illinois and New Hampshire, 1948; Florida, 1949.

[4] Includes red cedar.

[5] Ponderosa pine. The total volume of ponderosa pine in the United States is 185,441 million board-feet, including the 416 million feet in the Plains region.

TABLE 10.—*Volume of saw timber in the United States by species and by State and region* [1]—Continued

EASTERN HARDWOODS

[Million board feet]

State and region	Total	Oak	Beech, birch, and maple	Sweetgum	Tupelo and black gum	Cottonwood and aspen	Yellow poplar	Other
New England:								
Connecticut	1,384	830	415			13	28	98
Maine	12,508	139	11,046			1,234		89
Massachusetts	2,724	1,036	1,497			54	28	109
New Hampshire [2]	3,802	347	2,921			15		519
Rhode Island	131	114	9					8
Vermont	4,001	70	3,800			61		70
Total	24,550	2,536	19,688			1,377	56	893
Middle Atlantic:								
Delaware	664	339	46				20	259
Maryland	2,251	1,195	299			11	225	521
New Jersey	1,405	815	98			1	56	435
New York	18,353	1,835	13,397			918	184	2,019
Pennsylvania	17,495	11,114	3,705			206	206	2,264
West Virginia [2]	7,860	3,714	1,765			18	1,019	1,344
Total	48,028	19,012	19,310			1,154	1,710	6,842
Lake:								
Michigan	16,740	880	11,600			1,890		2,370
Minnesota	6,650	670	980			3,250		1,750
Wisconsin	11,650	3,540	4,510			1,240		2,360
Total	35,040	5,090	17,090			6,380		6,480
Central:								
Illinois [2]	10,306	5,832	864			299	[3] 181	3,130
Indiana [2]	6,169	2,581	1,618	86	31	167	334	1,352
Iowa	5,301	1,795	481			1,422		1,603
Kentucky [3]	10,781	6,010	2,070	285	87	12	1,400	917
Missouri [2]	11,169	7,538	287			419		2,925
Ohio [2]	9,062	3,606	2,686	3	113	39	390	2,225
Total	52,788	27,362	8,006	374	231	2,358	2,305	12,152
Plains:								
Kansas [4]	2,880	605				605		1,670
Nebraska [4]	1,200	36				1,092		72
North Dakota	414	9				355		50
Oklahoma (west)								
South Dakota (east) [3]	624					362		262
Texas (west)	144	52		36	3			53
Total	5,262	702		36	3	2,414		2,107
Total North	165,668	54,702	64,094	410	234	13,683	4,071	28,474
South Atlantic:								
North Carolina [2]	14,279	4,361	1,100	2,550	2,810		1,463	1,995
South Carolina [2]	11,963	2,626	689	2,425	3,397		1,208	1,618
Virginia [2]	13,318	6,211	944	1,194	974		2,195	1,800
Total	39,560	13,198	2,733	6,169	7,181		4,866	5,413
Southeast:								
Alabama	12,680	4,226		2,529	1,423		1,201	3,301
Florida [2]	4,717	1,086	188	629	1,578			1,236
Georgia	11,602	3,308		2,314	2,538		960	2,482
Mississippi [2]	16,949	6,749	546	3,113	1,262	454	500	4,325
Tennessee [3]	11,306	6,229	1,210	927	204	214	1,256	1,266
Total	57,254	21,598	1,944	9,512	7,005	668	3,917	12,610

See footnotes at end of table, p. 101.

TABLE 10.—*Volume of saw timber in the United States by species and by State and region*[1]—Continued

EASTERN HARDWOODS—Continued

State and region	Total	Oak	Beech, birch, and maple	Sweetgum	Tupelo and black gum	Cottonwood and aspen	Yellow poplar	Other
West Gulf:								
Arkansas	15,213	7,035	.....	2,525	779	584	.....	4,290
Louisiana	22,965	8,226	.....	4,323	3,470	250	.....	6,696
Oklahoma (east)	1,004	680	.....	57	34	.....	.....	233
Texas (east)	8,305	4,169	.....	1,736	764	.....	.....	1,636
Total	47,487	20,110	.....	8,641	5,047	834	.....	12,855
Total South	144,301	54,906	4,677	24,322	19,233	1,502	8,783	30,878
Total, all North and South [4]	309,969	109,608	68,771	24,732	19,467	15,185	12,854	59,352

[1] Prepared by Forest Service, U. S. Department of Agriculture. Status beginning of 1945, except as footnoted 2.

[2] Data from Forest Survey as follows: Missouri, Mississippi, and South Carolina 1947; Illinois and New Hampshire 1948; Florida 1949.

[3] Dead chestnut of sawlog size, still standing and usable, not included, as follows:

	Million board feet
West Virginia	453
North Carolina	342
Virginia	548
Tennessee	706
Total for North and South	2,049

Also small quantity in Indiana, Kentucky, Ohio, and elsewhere.

[4] Volume by species determined for Kansas by prorating to species according to data in forest survey reported in Kansas Agricultural Experimental Station Bulletin 285. For Nebraska, total prorated to species according to 1942 census of lumber production. For South Dakota, total prorated to species according to data on forest survey reported in 1936 by Lake States Forest Experimental Station in cooperation with South Dakota State Planning Board.

[5] Includes basswood.

TABLE 10.—*Volume of saw timber in the United States by species and by region*[1]

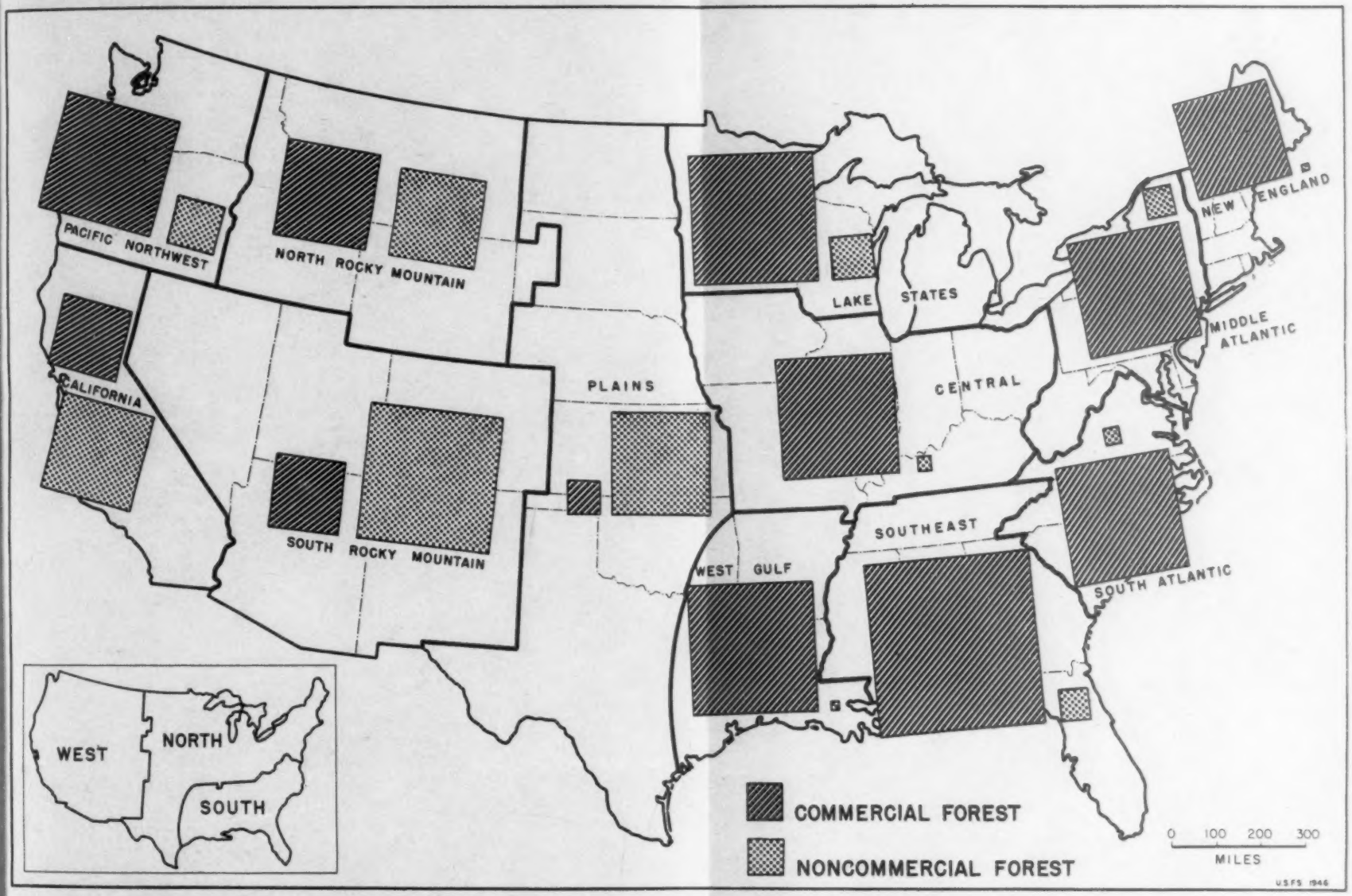
WESTERN SPECIES

[Million board feet]

Region	Total	Douglas fir	Ponderosa pine	True firs	Western hemlock	Sugar pine and western white pine
Pacific Northwest:						
Douglas fir subregion	504,931	310,523	4,850	46,464	94,469	6,171
Pine subregion	125,963	20,704	75,348	11,390	1,386	1,918
Total	630,894	331,227	80,198	57,854	95,855	8,089
California	227,565	[2] 68,613	[3] 51,191	[4] 43,012		19,505
North Rocky Mountain	127,229	26,718	26,771	9,360	1,352	12,630
South Rocky Mountain	56,868	3,470	26,865	3,315		
West	1,042,556	430,028	[6] 185,025	113,541	97,207	40,224

Region	Redwood	Spruce	Larch	Lodgepole pine	Other softwoods	Hardwoods
Pacific Northwest:						
Douglas fir subregion		8,020	145	37	30,386	3,866
Pine subregion			8,582	1,134	5,414	87
Total		8,020	8,727	1,171	35,800	3,953
California	[5] 38,114				7,130	
North Rocky Mountain		12,499	17,879	14,406	4,678	936
South Rocky Mountain		15,361		6,483	458	916
West	38,114	35,880	26,606	22,060	48,066	5,805

[1] Prepared by Forest Service, U. S. Department of Agriculture. Status beginning of 1945.
[2] May include some white fir, Sitka spruce, western hemlock, Port Orford cedar and western red cedar which are commonly lumped with Douglas fir in redwood cruising.
[3] Includes Jeffrey pine.
[4] Includes the western white pine, mountain hemlock, and lodgepole pine recorded in cruises of fir areas.
[5] Redwood exclusive of volume of 1,000 bigtree reported on cruises in the westside Sierra subregion.
[6] Excludes 416 million board feet in Plains region. Grand total of ponderosa pine in the United States is 185,441 million board feet.



DISTRIBUTION OF THE FOREST LANDS OF THE UNITED STATES BY REGIONS

24487 O - 52 (Face p.102)

NORTH
WEST
SOUTH
COMMERCIAL FOREST
NONCOMMERCIAL FOREST

Appendix F

REVIEW OF THE COMMERCIAL ATTEMPTS TO USE BAGASSE AS A PAPER-MAKING MATERIAL[1]

Bagasse (ba-gas') originally referred to the refuse of plants and now refers to the fibrous residue resulting from the crushing of sugarcane. It is not returned to the soil since the extraction of cane juices removes the soluble minerals leaving the tough fibers which are resistant to decay. Its use as a direct food as ensilage has been unsuccessful.

One proposed process for utilizing bagasse in paper dates back to 1838. Yet sugarcane was first used for paper stock about 1884. At that time bagasse was shipped from France to the island of Martinique. The fact that bagasse was mentioned as a paper-making material in patents of the 1840's and 1850's showed that paper made from bagasse was considered feasible.

In 1856, Thomas Routledge conducted a series of experiments using bagasse as one of a number of materials tried as a substitute for rags in paper. The results showed that the bagasse fiber was well adapted to paper-making purposes. Esparto was then favored over bagasse as a substitute because of the ease of collecting esparto grasses by cheap labor in nearby Morocco.

In 1856, Henry Lowe of Baltimore, Md., produced a creditable bagasse paper upon which was printed the Baltimore Advocate. A mill was erected in 1861 at Wilmington, N. C., for preparing bagasse fiber on a large scale as a raw material to paper mills. At this time page 153 of a book printed by Munsell was a specimen of southern cane paper.

Experiments were carried out at Elkton, Md., due to a shortage of cotton, resulting in the manufacture of several tons of paper from bagasse. This paper was found to be entirely satisfactory for printing the Philadelphia Public Ledger.

Very high grade printing papers were developed by Alfred Chapman, of Liverpool, England, while he conducted some experiments in 1870 for the Khedive of Egypt. The yield was insufficient to indicate commercial success.

Bagasse was printed into one edition of the New Orleans Daily Picayune. The paper was made of 50 percent rags and 50 percent bagasse.

Bagasse was converted during the 1880's into paper in southern mills, but all failed to make an economical paper since only the fiber was consumed. Bagasse was shipped to northern mills where experiments were carried out for its use in the manufacture of paper. A mill was proposed for Milford, Pa., in 1880, for Bayou Teche, La., and for Cape May, N. J., in 1881. In 1887, Ottawa, Kans., was suggested as a site for the manufacture of bagasse white paper.

An article in the Western Paper Trade of July 1884, welcomed this bagasse for paper making. This article in part follows:

"Recent experiments have demonstrated that very good paper can be made of bagasse. The New Orleans Picayune was recently printed on paper made of bagasse, and in making mention of this fact remarked that this opens a new field for investment of southern capital."

Few mills were built and many were planned in or near New Orleans. A mill being built by the Sugar Cane By-Products Co. having eight digestors and a capacity of 50 tons per day of bagasse pulp was announced by the 1879 Lockwood's Directory. In 1880, the Paper World announced that a mill was soon to be built in New Orleans to make bagasse pulp.

During this same period the Paper Trade Journal reported that the North and Central American Fiber Co. was planning a mill for New Orleans. In 1882, the Louisiana Fiber Working Co. built a mill in which many unsuccessful attempts were made to make paper from bagasse.

The National Pulp, Paper & Cordage Co. at Marrero made 1,400 pounds of soda pulp per day from Louisiana cane.

Bagasse pulp was produced for paper making by the Louisiana Fiber Working Co. in the parish of LaFourche, La.

[1] Material up to 1928 excerpted from report on Bagasse Utilization, Project No. 547, War Production Board. Material since 1928 excerpted from report submitted to Department of Commerce by the Mutual Security Administration.

Two tons of paper per day were made by a mill on the Belmont plantation in St. James Parish, 60 miles north of New Orleans. The Baton Rouge Sugar Co. planned a mill to make wrapping paper from bagasse in 1892.

In 1899, experiments were begun by C. Tenant Lee on paper from bagasse obtained in Louisiana and Cuba. An experimental plant was erected in Boston which ran for a year and a half. Lee concluded that a better field lay in the making of pressboard because of the difficulty of bleaching bagasse and its shrinkage. On the basis of these findings a Boston company erected a plant in Louisiana in 1907. It operated for about 2½ years, producing pressboard under a patented process. The yield was high and the product was dark in color. The material was satisfactory, but other factors brought failure to the company. The price of board was so low that there was no incentive to reopen the mill.

A cheap grade of paper was made from bagasse by the E. H. Cunningham Co. This paper was demanded by butchers and fish dealers who claimed that it was the best paper of its kind they had used. It was sold locally in Louisiana and Texas

Viggo Drewsen carried out an extensive series of experiments on bagasse at the mills of S. D. Warren & Co., Cumberland Mills, Maine. A number of patents were granted Drewsen as a result of these experiments. He succeeded in producing a good grade of paper, but his process required from approximately 4 tons of bagasse to make 1 ton of paper. The expense of bleaching was sufficient to discard his process.

In 1908, a bagasse mill was operated in Rio de Janeiro, Brazil, using the process employed by the E. H. Cunningham Co. This plant produced 1 ton of paper a day for 3 years. A high price of $100 per ton was maintained due to the high Brazilian tariffs and not to the quality of the paper. A plant was erected in the island of Trinidad by Lamar for making paper from a mixture of equal parts of ground grass or bamboo and ground bagasse. He marketed it both on the island and abroad. At least one issue of the Trinidad Mirror was published on paper from this mill. In 1911 a similar plant was started in Java.

Commercial tests on bagasse from Cuba were conducted at the Hollins Mills of the Wall Paper Manufacturers, Ltd., at Darwen, England, in 1908. About 200 tons of bagasse book papers were manufactured to meet the standards of certain characteristic writing papers.

In 1911, a small mill in Costa Rica produced paper using bagasse as a raw material.

Wrapping paper was successfully manufactured from bagasse in 1915 at Preston, Cuba. The mill was directed by graduate students and the work was done in connection with the University of Wisconsin laboratories. Operation of the mill ceased after a few months due to the small size of the mill, the increasing cost of chemicals, and the low-grade product.

The Sugar Cane By-Product Co. came into prominence in 1917 when it advertised inviting subscriptions to its stock. The company claimed to be erecting a mill at New Iberia, La. The mill was to convert bagasse into pulp according to a process patented by M. W. Marsden. A number of amazing possibilities appeared in their prospectus. This was merely a stock-selling proposition, as production was small and failure assured a short time later.

Arthur D. Little, Inc., conducted an extensive investigation of the possibilities of making paper from bagasse for the United Fruit Co. At this company's mill, a great variety of good paper was produced, but no commercial ventures were planned as a result of those findings and investigations.

The Olca Sugar Co. employed the Eckart process in the Hawaiian Islands and began production of an asphalt saturated felt for mulch paper about 1919. This was one of the successful attempts to use bagasse. About 28 tons of bagasse per 24 hours were consumed for the mulch paper and a yield of about 62 percent resulted from the bone-dry bagasse. The mill has proved very successful for the manufacture of the low-quality paper which is desired for mulching paper and which can be used in plastics.

The Celotex Corp., located at Marrero, La., was the first to produce successfully and economically products manufactured from bagasse, and has expanded until its operations are now very extensive. Its operation is explained in detail later in this report. Mr. C. G. Muench of Celotex has written:

"In 1920 a group headed by Mr. B. G. Dahlberg organized the Celotex Corp. to manufacture board made from the sugarcane fiber by a process originated and perfected by T. B. Munroe and J. K. Shaw. The original plant was designed for production of 60,000 feet of board per day, and this capacity has steadily increased until today, with seven machines installed, it has a total capacity of

2 million feet of Celotex board, refrigeration insulation, acoustic material, etc., which is marketed in practically every country in the world.

"In the early days, when the sugar mills were not as strongly built as they are today, the waste fiber or bagasse from the cane was dumped out in piles and burned after it had dried out. In some cases it was simply discharged into the Mississippi River. These were not only wasteful but costly operations. With the installation of much heavier crushing mills and Dutch ovens on the boilers it was found possible to use bagasse as a fuel so that at the time of the organization of the Celotex Corp. all of the mills were using bagasse as a part of their fuel, the balance being made up with wood, oil, or coal.

"During our preliminary investigations in connection with the manufacture of Celotex it was learned that considerable money and effort had been expended in efforts to produce commercially a satisfactory paper using bagasse as a raw material, but all attempts had resulted in failures.

"Before locating in Louisiana, a careful investigation was made of the various attempts at making paper to ascertain why these projects failed so as to prevent our making any mistakes that might have been made in these ventures. On completing our investigations it was evident that it was clearly a question of manufacturing cost and that as a commercial proposition, due to the high conversion cost for chemicals, power, labor, etc., a paper produced from bagasse could not compete with one made from wood. In making Celotex, however, we were not confronted with these problems and therefore able to produce a commercial article at a cost that it could be sold in large quantities.

"We have from time to time experimented with making paper from bagasse and in order to follow these experiments along more successfully with practical operating conditions, we purchased a mill of the Boldt Paper Co. located at New Iberia, La. While considerable paper has been made from bagasse, this mill at the present time is making box board for box manufactures and wrapping paper for Celotex products. All of the bagasse used in our plant is shipped in from sugar mills within a radius of 100 miles of the plant."

The success of the Celotex Corp. lies in their high yields of product and their low cost mechanical operations upon the bagasse.

In 1928, a mill was erected at Tuinucu, Cuba, by Cellulose Cubana which was to produce 40 tons of dissolving pulp per day by the De la Roza process. Many economic advantages were claimed and the mill was to be enlarged to a capacity of 120 tons. It was reported by De la Roza to be producing a high grade of alpha cellulose adapted for manufacture of rayon and similar high quality products and high-grade paper. Although it was claimed that the pulp was of higher quality than other dissolving pulps, and that it could be produced more cheaply than those pulps could be produced from wood, this mill was never successful and is no longer in operation.

According to an article in the Paper-Maker in 1932, it was proposed to erect a fiberboard factory in Jamaica in which the Vascane process was to be used. However, if this mill was actually constructed, it is not being operated at the present time.

In 1932 also the Hawaiian Cane Products Co. began operations for production of insulating board from bagasse, following the highly successful venture of The Celotex Corp. Although originally built and owned by the sugar interests, this mill is now operated very successfully by the Flintkote Co. for production of a great variety of structural insulating boards.

It was about 1938 or 1939 that successful commercial attempts began to materialize for production of pulp and paper from bagasse in various countries of the world. This period was preceded by rather intensive experimental work, including work in the Philippines, Japan, Peru, England, Argentina, Hawaii, and various parts of the United States.

The successful commercial ventures since 1938 are as follows:

1. Pilot plant of Cellulose Development Corp. in England

In 1939 an elaborate pilot plant was constructed at St. Paul's Cray, Kent, England, by the Cellulose Development Corp. for treatment of bagasse (among other fibrous raw materials, principally straw) by the Celdecor-Pomilio process. This pilot plant is still in existence and produces about 5 tons of bleached pulp per day from straw, bagasse, or other fibers. It has served to obtain background data and for development of new equipment for construction of a number of

commercial plants over the world which use agricultural residues, including bagasse.

2. The Bagasse pulp mills of the Taiwan (Formosa) Pulp and Paper Corp.

After extensive experimental and pilot-plant work, during the occupation of Formosa by the Japanese, two bagasse pulp mills were established which successfully used the acid magnesium sulfite process. One of these mills, the Taiwan Pulp Manufacturing Co. was located at Tatu, Taichung, and the other, called Ensviko Pulp Co. was at Hsinying, Taiwan. The Tatu mill started operations in 1939 and the Hsinying mill started in 1940 with capacities of 50 and 100 tons of bagasse pulp per 24 hours, respectively.

Both of these plants were put out of operation during the war by Allied bombing.

Since the war, the Taiwan Pulp and Paper Corp. has put the Hsinying mill back into operation for production of bleached bagasse pulp. This mill began operations again in 1947, but it has not yet been able to reach prewar production levels. The plant has abandoned the use of the magnesium base acid sulfite process and has adopted instead the monosulfite process, with a small concentration of caustic soda as a buffer.

A great variety of papers are being produced using a rather high proportion of this bagasse pulp.

3. Bagasse pulp and paper mill at Cia de Cellulose de Filipinas, Negros, Philippines

In 1941, following 5 years of work by the Compania General de Tabacos de Filipina, a small integrated pulp and paper mill was started up at Basis Central in the island of Oriental Negros in the Philippines. This mill used the continuous Celdecor-Pomilio pulping process of the Cellulose Development Corp.

This mill was in operation only a few months before the Japanese invasion. However, during that time, about 1,500 tons of bank note and bond papers were produced which contained more than 90 percent bleached bagasse pulp. The Japanese invasion forced a shut-down of this mill and it was not opened until April 1949.

This Philippine mill is now in operation at full capacity, which is only 15 tons per day. They use a dry method of separating pith from fiber and return the pith to the boiler plant. The fiber is then cooked and bleached by the continuous Celdecor-Pomilio process. The bleached pulp is converted into white lightweight bonds and writing papers on a 92-inch Pusey and Jones paper machine.

In addition to the paper, this mill also produces about 10 tons per day of low-quality paperboard on a small cylinder machine.

4. W. R. Grace Plant at Paramonga, Peru

In 1939 the W. R. Grace Co. began operating Peru's only pulp mill and largest paper mill, using bagasse as the principal raw material. This mill has operated successfully since that time and by blending the bagasse pulp with various grades of wood pulp a great variety of papers and boards have been produced, ranging from air-mail tissue to heavy board. Total production of bagasse pulp at this mill is now about 10,000 tons per year and the company reports that the operations are highly profitable.

5. The Ebro mill in Argentina

A mill for making low-quality pulp and paper from bagasse has been in production at Villa Ocampo, Santa Fé, Argentina, since 1943. This Ebro mill is affiliated with the Cia Industrial del Norte de Santa Fé, owners of the Arno cane sugar factory, near which it is situated. It is reported that this mill produces 25 tons of pulp per day, and 10 tons of paper.

6. Container Corp. of America mill at Cali, Colombia

For several years Container Corp. of America has operated a small paperboard mill in Cali, Colombia, Valle del Cauca, which uses bagasse. They produce about 15 tons of bagasse per day and mix this with wastepaper and wood pulp for manufacture of various grades of paperboard. This operation has been very successful.

7. Compania Celulosica y Papelera del Norte, S. A., in Cayalti, Peru

During early 1952 a second bagasse pulp and paper mill began operations in Peru. As mentioned in paragraph 4 above, W. R. Grace has been producing bagasse pulp there since 1939. The new mill, located at Cayalti, Peru, is also a small mill with production capacity of 25 tons per day. It was built in combina-

tion with a new sugar mill so that completely integrated operations can be carried out. It is reported that various grades of wrapping papers in colors are being produced at this mill.

8. Rohtas Industries, Ltd., Dalmianagar, Bihar, India

Encouraged by the success of the Philippine plant, the Dalmianagar organization in India completed a plant in 1951 for production of 24 tons per day of bleached bagasse pulp. Although some difficulty was experienced in the initial start-up of this mill, it is now running very successfully after only a short period of time. It is using the continuous Cellulose Development Corp. process for production of the bleached pulp.

9. São Paulo, Brazil

Refinadora Paulista, S. A. São Paulo, Brazil, is building a complete pulp and paper mill to use bagasse as the principal raw material. This mill should be in operation during 1952. They are also using the Celdecor-Pomilio continuous process which is being promoted by the Cellulose Development Corp. in England. Production capacity will be about 25 tons per day.

At the present time, projects are being considered, or are under construction in Egypt, Argentina, Puerto Rico, Hawaii, Louisiana, Mexico, Union of South Africa, Jamaica, the Dominican Republic, Cuba, and other cane-producing areas.

APPENDIX G

LETTER FROM FOREST PRODUCTS LABORATORY, DEPARTMENT OF AGRICULTURE, CONCERNING DE LA ROZA PROCESS

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE, FOREST PRODUCTS LABORATORY,
Madison, Wis., August 15, 1951.

Mr. JOAQUIN DE LA ROZA, Sr.,
De la Roza Corp., New York, N. Y.

DEAR MR. DE LA ROZA: As you know, a trial newsprint run was recently completed on our laboratory paper machine using bagasse pulp made by procedures that we understand follow essentially those of the de la Roza process.

In the preparation of the pulp a wide range of conditions were covered. The results indicate a good possibility of controlling the yield, strength, and chemical composition of the pulp for various use requirements.

Although there was no opportunity in the time available to determine optimum conditions for the quality of pulp for newsprint nor for making the paper, the results of the trial run on a small quantity of pulp are promising. The paper made in this trial had physical properties approaching closely those of standard newsprint. The strength properties of the paper were considerably higher than the standard and the sheet was much whiter. A considerable amount of filler was used, but the opacity of the sheet was slightly lower than the standard. These differences, however, are small and it is indicated that with minor adjustments the standard physical properties of newsprint could be attained.

Very truly yours,

G. H. CHIDESTER,
Chief, Division of Pulp and Paper.

Preliminary tests on bagasse papers from pulp made by the de la Roza process

Machine run number	3,588	3,589	3,589
Filler added, percent of moisture-free pulp	0	[1] 30	[1] 30
Sheet weight:			
Ream of 480 sheets, 24 by 36 inches, pounds	30.7	30.0	33.9
Ream of 500 sheets, 25 by 40 inches, do	37.0	36.1	40.9
Thickness, mils	2.7	2.9	3.2
Density, grams per cubic centimeter	0.76	0.69	.71
Bursting strength, parts per pound [2]	0.53	0.31	.36
Tearing resistance, grams per pound [2]	1.11	1.07	1.10
Tensile strength, pounds per inch width	12.5	8.4	10.9
Oil penetration, seconds		43.9	47.7
Porosity, do	43	37	
Opacity, percent	76	86.1	86.5
Brightness, do	68.0	71	71
Ash, do		11.0	11.0

[1] Filler composed of 67 percent celite (diatomaceous earth) and 33 percent clay.
[2] Ream of 500 sheets, 25 by 40 inches.

APPENDIX H

REPORT OF NORTHERN REGIONAL RESEARCH LABORATORY, PEORIA, ILL., ON PULPS FROM STRAW AND SUGARCANE BAGASSE FOR MANUFACTURE OF NEWSPRINT

[U. S. Department of Agriculture, Agricultural Research Administration, Bureau of Agricultural and Industrial Chemistry]

PULPS FROM STRAW AND SUGARCANE BAGASSE FOR MANUFACTURE OF NEWSPRINT

By E. C. Lathrop,[1] Northern Regional Research Laboratory,[2] Peoria, Ill.

Newsprint is a generic term used to describe paper of the type generally used in the publication of newspapers. The term "standard newsprint paper" as used in paragraph 1772 of the United States Tariff Act of 1930 has been interpreted by the United States Customs Court to be that form, class, or standard of newsprint paper which was chiefly used for printing newspapers on or prior to June 17, 1930. The Treasury Department has defined this paper by definite specifications, which are presented on page 237 in the Dictionary of Paper published under the auspices and direction of the American Paper and Pulp Association. This definition is particularly important from the standpoint of customs.

For many years before 1890 newsprint was made from straw pulp mixed with rags. After the process of preparing mechanical or groundwood pulp was discovered, this pulp was blended with straw pulp. Not long thereafter, however, the use of straw pulp was supplanted by wood pulp generally made by the sulfite process.

Present-day newsprint is composed of a blend of from 80 to 88 percent mechanical or groundwood pulp which is produced by grinding bolts of wood on a stone in the presence of water. The yield of such pulp is in the neighborhood of 90 to 95 percent. Because of the high yield from the wood and the simplicity of manufacture, mechanical pulp represents our lowest-cost source of wood pulp. In order to produce a sheet of paper which can be made on the present high-speed, wide newsprint paper machines, it is necessary to add a certain proportion of stronger pulp produced by cooking pulpwood with chemicals. Ordinarily this is spruce or hemlock sulfite pulp.

The characteristics of opacity, ink absorbency, softness, and bulk in newsprint are mainly due to the mechanical pulp. Experience shows that chemical pulp does not have these qualities to the same extent as the mechanical pulp. On the other hand, it is possible to replace the spruce sulfite pulp with a bleached kraft pulp as is done in Australia and also, as we have discovered, with bleached straw pulp and with bleached sugarcane bagasse pulp. All of these chemical pulps have the property of giving a wet sheet strong enough to run through the presses and over the driers in the present high-speed paper machines.

While newsprint paper is considered one of the lower grades of printing papers, it is really a highly specialized product. It is manufactured on the largest paper machines and at the highest production speeds of any of our printing papers. Therefore, consideration must be given particularly to the qualities of the pulp required for such operating conditions. In use, newsprint must run on the modern high-speed printing presses with relatively few breaks. It must be capable of absorbing the cheap news inks rapidly and yet receive sharp impressions of types, cuts, and printing plates without blurring. It must have sufficient opacity so that little or no "show-through" (that is, printing on one side of the paper must not be easily discernible from the other). It must be relatively stable dimensionally for good register in color printing, and be relatively clean and sufficiently bright to obtain good contrast and easy reading without eyestrain.

Since newspaper advertising pays most of the cost of our daily newspapers, the advertisers are responsible to a considerable extent for those special qualities which have developed in newsprint requirements over the years. The paper

[1] Chemical engineer, head of agricultural residues division, Northern Regional Research Laboratory.
[2] One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

makers, in cooperation with publishers, press manufacturers, and ink manufacturers, have all contributed notably to the advances in newsprint quality. A change in the paper or in the way ink is absorbed by it will obviously affect its running qualities on the presses, its tendency to smear, its show-through, and other important characteristics.

There have been a number of proposals to make newsprint out of 100-percent chemically pulped straw or bagasse or even chemical wood pulps, although wood pulps at present are not under consideration because of the pulpwood shortage. The action of chemicals in pulping is to remove from the raw material certain constituents which are responsible for the particular characteristics of ground wood. Chemically produced pulps all have a different and lower ink absorption than mechanical pulp and, generally, less opacity although opacity can be increased by the use of filler material such as clay. Certainly, pulps can be produced from straw or sugarcane bagasse which can be made into paper of newsprint weight and which would run satisfactorily over the present printing presses. But such paper would not look like or behave like present standard newsprint and changes would have to be made in the types of ink used for printing. In addition, the cost of such paper would tend to level out at a price higher than that of present newsprint; although under emergency conditions, where entirely free markets may not exist, there might be periods during which such 100-percent straw or bagasse paper could be competitive with standard newsprint. Of course, in countries where mechanical pulps are not available, the publishers might very well be satisfied with a different type of sheet. After all, it is the publisher who will eventually decide whether a product differing from standard newsprint is acceptable to the newspaper trade.

Experiments conducted over the past 3 years by our Northern Regional Research Laboratory group, in cooperation with industry and with the Forest Products Laboratory, have a direct bearing on this subject. The first of these experiments was run at the request of the Ontario Paper Co., Thorold, Ontario, who manufacture the newsprint for the Chicago Tribune and the New York Daily News. The company desired to determine, during the emergency in 1949 when the price of wood pulp was advancing so rapidly, if other raw materials besides pulpwood would be suitable as a supplement in newsprint manufacture. At that time a new chemical process for pulping straw had been developed at this laboratory. The process gave a higher yield of strong pulp than had been obtained by previous methods, and it was used for preparing the straw pulp on a commercial scale at the Ontario mill. This pulp, after screening, was given a mild bleaching treatment and was blended with the standard mixture of mechanical and spruce sulfite pulps to the extent of 17 to 20 percent of the total pulp used in making the paper. This blend was run on a large, high-speed, modern newsprint paper machine for 7 to 8 hours, producing from 35 to 40 tons of newsprint paper. No changes were required in the paper-machine operation, and the straw pulp was entirely satisfactory from the standpoint of manufacturing operation. The paper so prepared was judged to be of somewhat better formation and smoother finish than standard newsprint. It was shipped to the Chicago Tribune and run into 163,000 copies of a 28-page edition without a single break on the presses. The printing characteristics of the paper were enough improved over the standard sheet so that it was possible to determine by inspection which paper contained the straw pulp. This run proved definitely that bleached straw pulp can replace all or most of the spruce sulfite pulp as the chemical, strength conferring constituent in standard newsprint, when used with fresh mechanical ground wood.

This laboratory has entertained for some time the idea that it would be possible during an emergency and, indeed, in normal times to produce newsprint in another manner, using straw or bagasse pulp with deinked waste news. It was proven during World War II that under proper campaigning large amounts of waste paper could be collected at reasonable costs. For many years a variety of papers, particularly for magazines, have been manufactured by collecting printed magazine papers and de-inking these by a chemical process. It is possible to do a satisfactory job of de-inking waste printed newspapers. The pulp produced in this manner would supply the mechanical pulp characteristics which are so necessary in the present-day news sheet, and the chemical pulp required for giving the strength characteristics to the sheet could be supplied by the use of chemical straw or bagasse pulp.

In May 1951 in a cooperative project between the Forest Products Laboratory, Madison, Wis., and the Northern Regional Research Laboratory, Peoria, Ill., straw pulp prepared by a new, streamlined, simple process was blended with

unprinted waste newsprint to produce newsprint paper. The straw pulp was obtained by digesting the straw in an open vessel for one-half hour at about 210° F. The pulp was then washed, screened, and bleached. The yields of straw pulp obtained were high as compared with conventional processes. The paper produced from a blend of 20 percent of this straw pulp and 80 percent of the waste unprinted news was produced on the experimental machine of the Forest Products Laboratory. The paper had considerably better formation than is usually found in newsprint and it also had better strength characteristics all around. The color of this paper using bleached straw pulp was considerably lighter than that obtained for the common newsprint. It would appear from this experiment that it is entirely feasible to produce what we would call standard newsprint today from a mixture of deinked waste newsprint and chemical straw pulp.

In order to determine that there would be no difficulty in replacing the softwood sulfite chemical pulp used in manufacturing standard newsprint by either bleached straw or bleached sugarcane bagasse pulp, some further experimental runs were made in a cooperative project between the Forest Products Laboratory and this Laboratory in November 1951. Newsprint was made from 20 to 30 percent of bleached straw pulp and bleached bagasse pulp blended with softwood and hardwood mechanical pulps. A control run using 20-percent softwood sulfite and the same mechanical wood pulps was made for comparison. The newsprint produced from the straw and bagasse pulps blended with the groundwood pulps was fully equal to that produced with the all-wood furnish.

In connection with sugarcane bagasse, the Northern Regional Research Laboratory has under development a process for separating pith from the fibers of such bagasse as it comes from the sugar mill. The presence of pith in sugarcane bagasse ordinarily decreases the yield of pulp, increases the cost of bleaching, and causes a pulp of slower drainage on the paper machine.

To recapitulate, it has been shown that a paper having the properties of standard newsprint may be produced (*a*) by replacing part of the furnish in standard newsprint by bleached straw pulp; (*b*) by repulping unprinted newsprint paper and adding to this pulp 20 percent of bleached straw pulp—this indicates that it should be possible to manufacture satisfactory paper for use by the newspaper publishers by deinking newsprint and using either bleached straw or bleached sugarcane bagasse pulp to supply the chemical pulp required to give the necessary strength and life to the paper; and (*c*) it is indicated that virgin mechanical pulps made either from the conifers or from the hardwoods can be converted to satisfactory newsprint by the addition of 20 to 30 percent of either bleached straw or bleached sugarcane bagasse pulps, and this has been determined by trial runs on the experimental paper machine at the Forest Products Laboratory.

What we call standard newsprint cannot be made from 100-percent chemical pulp from any material, either softwoods, hardwoods, straw, bagasse, or other wastes since the chief properties of newsprint are dependent on the presence of the mechanical pulp. However, it is entirely possible to manufacture papers which can be printed and run on high-speed presses. It is probable that over a period the manufacture of such papers may prove to be more expensive than the manufacture of standard newsprint, and the deciding factor in the use of papers of this type depends on their reception by the public and particularly the willingness of publishers to contract over a period of years for the use of papers of this character.

APPENDIX I

NEWSPRINT PROBLEM IN INDIA—AN IMMEDIATE SOLUTION

By M. P. Bhargava, retired chief research officer, Cellulose and Paper Branch, Forest Research Institute, Dehra Dun

Reprinted from Indian Pulp and Paper, July 1951

The manufacture of newsprint paper from bagasse (sugarcane residues) in India is shown to be a commercially feasible proposition in view (*a*) of the recent remarkable developments in the technique of producing, cheaply and economically, bleached pulps from hardwoods and agricultural residues, (*b*) of the easy availability of coal in the country, in supplies adequate to replace bagasse as fuel in sugar factories, and (*c*) of the production every year of about 4 million tons of bagasse in sugar factories.

Of late, there has been an acute shortage of newsprint, not only in this country but also in other countries of Asia, Western Europe, South America, Africa, Australia, etc. Newsprint prices have gone up abnormally high, almost everywhere. A few weeks back, newsprint was quoted at £60 per ton in England. The present prices of newsprint per ton in U. S. A. and Canada are quoted as $116 and $112, respectively, and the current market price of newsprint in this country is perhaps Rs. 800–900 per ton. A number of economic and political factors are responsible for this abnormal situation. It is not possible to discuss these factors in the short space of this article, nor is it possible to analyze and predict the future trends in the world price levels of newsprint paper. However, as far as is possible to look ahead, the possibility of the price levels returning to normality in the near future appears to be rather remote.

In spite of vigorous efforts, even at Government levels, India has not been successful in procuring, from abroad, more than a fraction of her minimum requirements of newsprint and, unfortunately, it has not yet been possible to manufacture the paper in the country.

Considering that newsprint is a commodity of vital necessity and importance to national economy, both in peace and war, and for the growth and development of Democracy and knowing that paper-making raw materials abound in the country, national honour and interests demand all-out efforts to be made to render her largely self-sufficient in the immediate future, with regard to her ever-increasing requirements of newsprint. How long is the country to go round to North American and Scandinavian countries with a beggar's bowl in hand and be content with whatever quota is doled out to her at a time? How long is the country to suffer an annual drain of crores of rupees in foreign exchange for the purchase of her newsprint requirements?

The main and principal obstacle, which has, so far, stood in the way of the development of the newsprint industry in the country, has been the non-availability, at economic prices, of suitable pulpwoods for the production of groundwood pulp, large quantities of which, according to the orthodox tradition, are required for use in the manufacture of newsprint. The use of groundwood pulp in large proportions (a minimum of 75–80 percent of the mixture of chemical and groundwood pulps) has been necessary for the sole purpose of manufacturing newsprint at the lowest possible cost. Groundwood pulp is produced by grinding soft whitewoods against stones without the use of chemicals, which are necessary for the production of chemical pulps. Further, the yield of groundwood pulp, per unit of wood, is about twice as much as that of chemical pulp. For these reasons, groundwood pulp is comparatively much cheaper than chemical wood pulp and hence its universal use in large proportions for the manufacture of the lowest priced printing paper—newsprint.

In the important newsprint manufacturing countries—Sweden, Norway, Canada, and U. S. A.—conifers (spruce, fir, hemlock, etc.) have been available in plenty and at economic costs. These woods are materials *par excellence* for the production of groundwood pulp and, therefore, have been used, almost exclusively, for the purpose, in those countries.

In countries where conifers do not occur, soft light coloured woods of the broad-leaved species, popularly called hardwoods, have been successfully utilized

in recent years for the production of newsprint grade groundwood pulp. For example, in Italy a flourishing newsprint industry has been established, based on the use of poplar wood (Populus alba and Populus canadensis) grown as a crop on 10–12 years' rotation. The annual production of ground wood pulp from poplar has been about 140,000 tons and all the newsprint in Italy is manufactured from 100 percent poplar groundwood pulp, admixed with semichemical poplar pulp. It would be interesting to mention that plantations of poplar were raised in Italy under orders of Mussolini, with the specific object of rendering the country self-sufficient with regard to her newsprint requirements. Again, in Australia, after prolonged and patient research, involving a large expenditure of money, newsprint manufacture has been firmly established, based on the use of Eucalyptus species for the production of groundwood pulp. The production of newsprint in Australia has been about 35,000 tons per year. Within a year's time this production is expected to be raised to 60,000–80,000 tons per annum. Further, promising researches have been carried out, which would enable the imported chemical sulphite wood pulp, required to be admixed in proportions of 20–22 percent with Eucalyptus groundwood pulp, to be replaced by indigenously produced Eucalyptus sulphate (Chemical) pulp.

In India, extensive forest areas of spruce and fir (coniferous woods) have been known to exist in the Himalayan regions. They, however, occur at altitudes of 9,000–10,000 feet above sea level and in such difficult and rugged terrains that their exploitation for the newsprint industry has not, hitherto, been found possible or practical. It appears from newspaper reports that the Government of India have requested the FAO for the services of three experts to explore the possibilities of, and recommend measures for, the exploitation of Himalayan spruce and fir for newsprint manufacture. The report of the experts will be awaited with great interest. It will show what sustained supplies of spruce and fir can be available from the Himalayan regions and at what prices. It seems, however, almost certain that an initial expenditure of a large sum would be necessary for the adoption of modern mechanized methods of extraction and transportation of pulpwoods to a suitable paper manufacturing site.

It has also been known that pulpwoods of the broad-leaved species (hardwoods), suitable for the production of newsprint grade groundwood pulp, are not available in any part of the country, in quantities adequate to support a modern newsprint mill. It was for this reason and because of the reported unavailability of conifers from the Himalayan regions, that a project was started some years ago at the Forest Research Institute, Dehra Dun, to test a number of hardwoods, with a view to select a few species, which could be grown on a short rotation in suitable localities and from which newsprint grade groundwood pulp could be successfully manufactured. The investigations, which are still in progress, have so far shown that few species, *e. g.*, Kydia calycina (*bendi*), Excaecaria agallocha (*genua*) and Broussonetia papyrifera (Paper mulberry) are promising for the purpose. Plantations of these species have to be raised, if it is decided upon to utilize them for groundwood pulp manufacture. There is, therefore, no prospect of any of the suitable broad-leaved (hardwood) species being available for groundwood pulp production, for at least some years to come. It is hoped research on the subject will continue at the Forest Research Institute, Dehra Dun, with a view finally to fix a few species best for plantation and for groundwood pulp production.

The unavailability of pulpwoods (conifers and hardwoods) need not, however, preclude the possibility of starting newsprint manufacture in this country now or in the immediate future. Generally speaking, newsprint is a lowest priced printing paper fulfilling the minimum specifications of printing and strength characteristics, required for a modern high-speed rotary printing press. If the two requirements of low price and printing and strength characteristics are possessed by a paper it can be called and used as "newsprint," irrespective of the fact whether the conventional groundwood pulp, in any proportions whatever, is employed in its manufacture or not.

In the last few years, marvellous developments have been made in the techniques of producing cheaply and economically bleached pulps from hardwoods and agricultural residues, which are available in many countries in huge supplies and at comparatively much cheaper prices than coniferous woods. As a result of these developments, about 3.5 million cords of hardwoods (15 percent of the total pulp wood consumption) were used in U. S. A. in 1950, for the production of a variety of pulps, some of which successfully replaced chemical pulps from conifers in the manufacture of such papers as book, magazine, tissues, etc. At the new Natchez, Miss., Mill of the International Paper Co., hardwoods have been used

almost exclusively for the manufacture of dissolving pulp, used in the manufacture of rayons, staple fibre, and other cellulose products. The mill has a production capacity of 300 tons pulp daily or 90,000 tons per annum.

For nearly the last 10 years, fine papers such as banks and bonds, papers much superior to newsprint, have been manufactured from 95-percent bagasse chemical pulp in a mill in the Philippines.

In Peru, for the last few years, Sociedad Agricola Paramonga, Ltd., a subsidiary of W. R. Grace & Co., have been manufacturing, in their mill at Paramonga, newsprint and a large variety of other papers and boards, from 100-percent bagasse chemical pulp.

In Italy, Holland, France, Austria, Western Germany, U. S. A., and Brazil, great and remarkable strides have been made in recent years in the production of bleached pulps from hardwoods (poplar, beech, etc.) and straws, for use in the manufacture of a variety of boards and papers, including newsprint and dissolving pulps. These developments are full of tremendous potentialities, in view of the growing scarcity of coniferous woods and of their rising prices.

The remarkable success achieved, in recent years in several countries, in the utilization of hardwoods and agricultural residues for the manufacture of paper and boards, are highly encouraging and significant. They indicate the lines on which a practical solution of the difficult problem of newsprint manufacture in this country could be worked out. In the light of the pulping techniques evolved and developed in recent years, the writer has, of late, carefully studied and made reliable enquiries pertaining to the practical aspects of manufacturing bleached chemical pulp from bagasse (crushed sugarcane residues) and has come to the conclusion that its utilization offers an *immediate* solution to the problem of successfully manufacturing newsprint in the country.

It is well known that enormous quantities of bagasse are produced every year in the sugar factories in this country. About 3 years ago, investigations on the raw material were carried out by the writer at the Forest Research Institute, Dehra Dun, and bleached writing and printing papers were successfully manufactured from 100-percent bagasse on the small pilot paper machine there. This investigation, coupled with the fact mentioned earlier, that newsprint has been actually manufactured in Peru from 100-percent bagasse chemical pulp, for the last few years, definitely establishes the feasibility of utilizing the material for the manufacture of newsprint quality paper. The utilization of the material for the purpose is, therefore, no longer a technical problem for experimentation now. It is mainly a problem of economics and organization.

Hitherto bagasse has been used, in the sugar factories, as fuel, for steam and power generation. The principal reason for this has been that neither alternative fuel for the purpose has been available, nor has there been any outlet for a more economic use of the large quantities of bagasse produced in the factories. Its use, therefore, as fuel has been the easiest, most convenient and the cheapest method of disposal.

The situation, however, has changed now. The position of coal supplies has considerably improved of late. Plentiful supplies of coal are available in the country so much so that it has been possible to export it to other countries. There should, therefore, be no difficulty in procuring requisite supplies of coal for the two or three sugar factories, from which bagasse is to be released for paper manufacture. For one ton of newsprint quality paper produced, based on the relative calorific values of bagasse and coal, approximately two tons of coal will be required to be supplied to the sugar factories for procuring the requisite quantity of bagasse in exchange.

The substitution of coal for bagasse, as fuel, would be decidedly advantageous to sugar factories. It would contribute to greater heat economy and general cleanliness in the factories. Further, it would serve to minimize, to a great extent, fire hazards, inherent in heaps of bagasse lying about in factory compounds. The use of coal in sugar factories would, of course, necessitate changing the steam boiler grates from bagasse to coal burning. This can be easily effected at an expenditure of about Rs. 50,000–60,000 per steam boiler. The total expenditure involved in effecting the change would, thus, be a comparatively very small investment for ensuring procurement of the required supplies of raw material for the paper mill. Reliable enquiries, recently made, show that the cost of bone-dry bagasse, inclusive of baling and transportation charges, etc., delivered at the paper mill site, in close vicinity of the sugar factories, is likely to be about Rs. 28–30 per ton. The availability of material at such cheap rates and the established possibility of successfully converting it into paper, open up a vast outlet for its utilization, far more

economic than its use as fuel. The value of paper produced from a given quantity of bagasse is roughly about 12 times as much as its fuel value, in terms of coal.

In view of the expediency and desirability of the regional distribution of large-scale factories in the country and of the necessity of avoiding, as far as possible, long and expensive haulage of raw and finished materials over long distances, the best course appears to be to locate one paper-making unit just large enough to be commercially economic, adjacent to or in close vicinity of two or three sugar factories, where reasonable paper-manufacturing facilities may also be available. The sugar factories selected must, of course, be large enough to provide adequate supplies of bagasse for the economic manufacture of newsprint-quality paper. A cursory survey, made in U. P. about three years ago, showed that a few sites, fulfilling the above-mentioned requirements, were available in the State. There is no doubt that equally good or even better sites may be available in other States as well, where sugar factories exist.

In conformity with the above requirements and with a view to secure, to the maximum possible extent, economies of large-scale production, an optimum unit appears to be a mill with a production capacity of about 20,000 tons of newsprint-quality paper per annum.

The total quantity of bagasse (48-percent moisture) required annually for the above production of paper would be approximately 120,000 tons. This quantity should be available every year, without difficulty, from 2 or 3 large sugar factories. The total quantity of coal, required for the exchange of the above quantity of bagasse would be about 40,000 tons annually or only about 0.13 percent of the annual raisings of coal in the country.

The total capital expenditure on modern and efficient machinery (including power plant) and buildings, etc., necessary for putting up a mill for an annual production of about 20,000 tons of newsprint-quality paper is tentatively estimated to be about Rs. 200–250 lakhs. Of this amount, it is expected that not more than two-thirds or about Rs. 150–160 lakhs would be required in foreign exchange for the purchase of machinery abroad, that is, an amount almost equal to the purchase value of 20,000 tons of newsprint at the current prices. This expenditure of foreign exchange, once incurred, will thus stop, for the future, an annual drain of almost an equivalent amount.

The cost of white newsprint quality paper, produced in the proposed unit, is estimated on a conservative basis to be about Rs. 600–650 per ton. In arriving at the estimate, the cost of bone-dry bagasse is taken at Rs. 28–30 per ton and the prevailing prices of chemicals, coal, machine accessories, and other items have been taken into account. The estimate also includes labour and supervision charges and depreciation or machinery and buildings at the current prevailing rates.

It will be seen that the above estimated cost of production is less than half of the current controlled prices of Indian-made writing and printing papers and is favourably competitive with the price of imported newsprint quality paper. In other words, newsprint quality paper, manufactured from bagasse, promises to be the lowest-priced printing paper available in the country. In case there is an appreciable fall in future in the world newsprint prices—a highly improbable eventuality—there would be a strong case then for the grant of "protection" to the indigenous newsprint industry, vitally essential to national economy.

It is very difficult to predict the position of bagasse newsprint vis-à-vis the newsprint contemplated to be manufactured from Himalayan conifers or that proposed to be manufactured at the Nepa Mills, Madhya Pradesh. It is not possible to say anything about the future of the two projects. The first project has yet to be investigated by a body of experts. Definite and authoritative information about the details of the second project has not been available to the public. Even if the two projects materialize and start functioning in the near future and produce newsprint at costs competitive with or lower than that of bagasse newsprint, the market for the latter is, in all probability, likely to continue. The total output of newsprint paper from the two pulpwood projects will hardly be sufficient to meet the present requirements of the country (about 60,000 tons per annum), not to speak of the greatly increased demand of the future. Bagasse newsprint will, therefore, still be required to meet the unsatisfied balance demands. If, at the worst, bagasse paper is unable to sell as newsprint, it would be quite feasible to manufacture, from the raw material, bleached writing and printing papers, intermediate in quality to and at a cost much lower than the costs of bamboo and grass papers. The entire output of the proposed bagasse unit will, therefore, find a ready and assured market as cheap writing and printing papers, for which there is bound to be a large demand in the near future, not

only for mass literacy campaigns but for a multitude of other purposes. *Prima facie*, therefore, there is no appreciable or unusual risk involved in putting up the proposed unit for the manufacture of newsprint quality paper from bagasse.

On the other hand, if bagasse newsprint is able to compete successfully with newsprint manufactured from conifers from the Himalayas or from a mixture of bamboo and *salai* wood (Boswellia serrata) pulps at the Nepa Mills, the practical experience, acquired in the working of the proposed unit would enable further easy expansion of the industry to meet the country's entire demand of newsprint not only in the near future but for a long time to come, since a very large potential supply of bagasse (about 4 million tons are produced annually in sugar factories alone) can be easily available for the industry.

The early establishment of the proposed unit, therefore, bids fair not only to afford a very welcome relief to the near-famine conditions of newsprint supplies in the country, by placing at her disposal, in the immediate future, almost one-third of her present-day requirements, but is a very promising and substantial step forward in the drive for rendering the country self-sufficient with regard to a commodity essential and of vital importance to her national economy. With War clouds overhanging the world, it is hoped that entrepreneurs and industrialists will appreciate the imperative necessity of taking suitable measures for the very early materialization of the project. There is no doubt that the Central and the State Governments will extend all possible help and encouragement to the fruition of a scheme of great and immediate importance to national economy.

APPENDIX J

DATA CONCERNING BAGASSE PRODUCTION AND USE IN HAWAII

HAWAIIAN SUGAR PLANTERS' ASSOCIATION,
San Francisco 5, Calif., July 9, 1952.

(1) *Production.*—Presently about 2,000,000 tons of mill bagasse are produced annually by the 27 raw-sugar factories in the Hawaiian Islands. When used, it consists of about 50 percent moisture; so the bone-dry bagasse is reduced about 1,000,000 tons, or approximately 1 ton for each ton of commercial sugar produced. It is the object of our present research to increase revenues from this bagasse in order to improve the economy of the islands.

(2) *Uses.*—Except for an amount not over 50,000 tons, the balance is used as fuel in the 27 raw-sugar factories. Practically no surplus is involved, as is the case for so many other cane-producing areas where different varieties, harvesting conditions, etc., produce more bagasse per ton of sugar than is the case for the Hawaiian Islands. The 50,000 tons of bagasse mentioned above are sold to a commercial manufacturer of wallboard at Hilo. Obviously, conversion to other products would be greatly increased in quantity if our investigations prove the commercial possibilities of using bagasse for the manufacture of paper, livestock feeds, etc.

(3) *Approximate cost.*—Generally speaking, the present cost of bagasse at the mill is equivalent to its fuel-oil value. Approximately the B. t. u. equivalent of 1 ton of bone-dry bagasse is that of 2½ barrels of oil. The latter is about $2.50 per barrel at the plantations, which would mean that a ton of bone-dry bagasse at each of the mills is valued at about $6.25 per ton. That presently sold to the commercial manufacturer of wallboard also approximates this figure, plus, of course, the cost of preparing the bagasse, such as baling, for shipment to the commercial plant.

(4) *Locations of the greatest supply concentration.*—The above-mentioned million tons of bone-dry bagasse are produced on four of the sugar-producing islands, divided approximately as follows:

Islands:	*Tons*
Maui	220,000
Hawaii	405,000
Oahu	217,000
Kauai	218,000
Total	1,060,000

Details of production by plantations are shown on the attached exhibit No. 1. Exhibit No. 2, on the other hand, shows a map of the four islands involved, together with the approximate location of each of the plantation factories. You will note that, as far as concentration is concerned, the largest volume is probably on the island of Maui, where Wailuku and H. C. & S. Co. have three factories (within 12 miles of each other) producing 164,000 tons of bone-dry bagasse per year. This probably represents the highest concentration with the least amount of transportation involved.

A similar condition but involving longer haul exists on the island of Oahu, where three large factories located not more than 15 miles apart produce quantities as listed below:

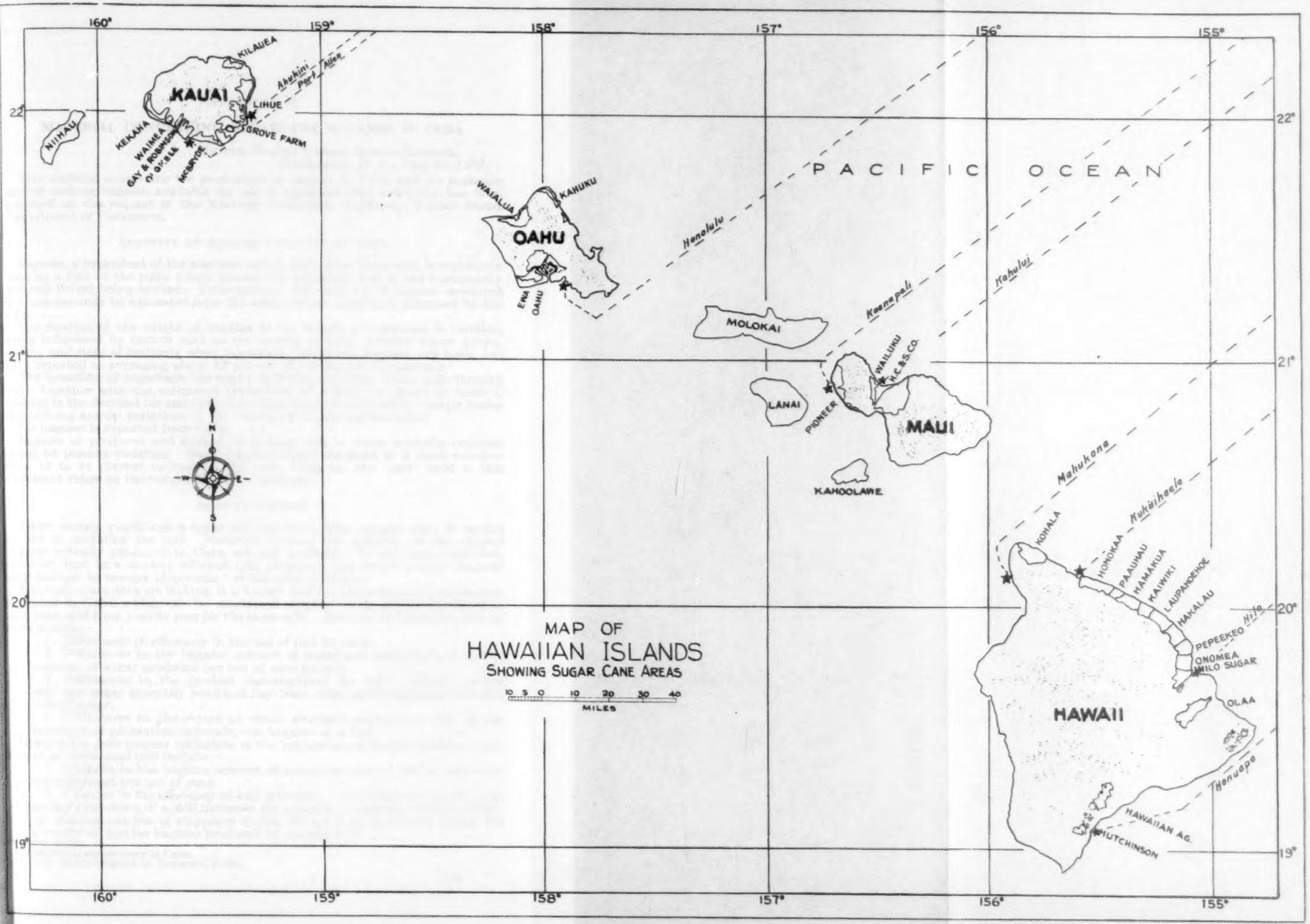
Oahu Sugar Co	84,000
Ewa	60,000
Waialua	53,000
Total	197,000

Attention is called to one important consideration in the production of bagasse in the Hawaiian Islands, namely, the fact that the cane-harvesting season extends from 9 to 10 months per year and thus very little baling and storage for so-called off-season would be involved. This is one of the major Hawaiian advantages when considering the production of byproducts from residual cane.

EXHIBIT No. 1.—*Production of bagasse by factories and location in Territory of Hawaii*

	Bone-dry tons, bagasse
Kauai:	
Grove Farm	20, 000
Kekaha	43, 000
Kilauea	11, 000
Lihue	73, 000
McBryde	28, 000
Olokele	43, 000
Oahu:	
Ewa	60, 000
Kahuku	20, 000
Oahu	84, 000
Waialua	53, 000
Maui:	
H. C. & S. Co., Paia	55, 000
H. C. & S. Co., Puunene	82, 000
Pioneer	56, 000
Wailuku	27, 000
Hawaii:	
Hakalau	32, 000
Hamakua	24, 000
Hawaiian Agriculture	46, 000
Hilo	[1] 33, 000
Honokaa	32, 000
Hutchinson	15, 000
Kaiwiki	15, 000
Kohala	60, 000
Laupahoehoe	[1] 19, 000
Olaa	[1] 61, 000
Onomea	[1] 24, 000
Paauhau	20, 000
Pepeekeo	24, 000
Total	1, 060, 000

[1] Plantations selling portion of their bagasse production to the Pioneer-Flintkote wallboard plant in Hilo, Hawaii.



MAP OF HAWAIIAN ISLANDS

SHOWING SUGAR CANE AREAS

10 5 0 10 20 30 40

MILES

24487 O - 52 (Face p.118)

KAUAI
OAHU
MAUI

APPENDIX K

MATERIAL CONCERNING SUGARCANE BAGASSE IN CUBA

UNITED STATES CUBAN SUGAR COUNCIL,
Washington, D. C., July 10, 1952.

This material concerning the production of bagasse in Cuba and the probable cost of making bagasse available for use in manufacturing newsprint has been prepared at the request of the National Production Authority, United States Department of Commerce.

QUANTITY OF BAGASSE PRODUCED IN CUBA

Bagasse, a byproduct of the manufacture of sugar from sugarcane, is commonly used as a fuel in the mills which process the sugarcane and is not customarily weighed before being burned. Consequently, the quantity of bagasse produced in Cuba can only be estimated from the weight of the sugarcane processed by the mills.

The relation of the weight of bagasse to the weight of sugarcane is variable, being influenced by factors such as the variety of cane, country where grown, season, and state of maturity when harvested. However, bagasse, dry basis, has been reported as averaging about 12 percent of the weight of sugarcane.[1]

The quantity of sugarcane harvested in Cuba, by years from 1935 through 1951, together with the estimated production of bagasse, is shown in table I. Change in the demand for and output of sugar from year to year is a major factor determining annual variations in the tonnage of sugarcane harvested.

No bagasse is exported from Cuba.

Bagasse as produced and burned by a sugar mill in Cuba normally contains about 50 percent moisture. Baled bagasse stored outdoors in a stack contains from 12 to 14 percent moisture. The term "bagasse, dry basis" used in this statement refers to the weight free from moisture.

SURPLUS BAGASSE

Under certain conditions a sugar mill produces more bagasse than is needed as fuel in operating the mill. Statistics showing the quantity of this surplus bagasse actually produced in Cuba are not available. It has been estimated, however, that in a modern efficient mill producing raw sugar, surplus bagasse may amount to around 15 percent [2] of the total produced.

Although exact data are lacking, it is known that the proportion of total bagasse produced in Cuba which can be considered surplus varies widely among mills each year, and from year to year for the same mill. Reasons for variations among mills include—

1. Differences in efficiency in the use of fuel by mills.
2. Differences in the bagasse content of sugarcane processed and in the quantity of sugar produced per ton of cane ground.
3. Differences in the product manufactured by mills. Plants making only raw sugar generally need less fuel than those producing both raw and refined sugar.
4. Differences in the extent to which auxiliary enterprises, such as the operation of plantation railroads, use bagasse as a fuel.

Reasons for year-to-year variations in the proportion of surplus bagasse available at an individual mill include—

1. Changes in the bagasse content of sugarcane ground and in the sugar manufactured per ton of cane.
2. Changes in the efficiency of mill operation. Anything causing the temporary shut-down of a mill increases the quantity of bagasse needed for fuel. An unusual number of stoppages during the grinding season will reduce the quantity of surplus bagasse produced by a sugar mill.

[1] Experience of one company in Cuba.
[2] S. Rept. 1404, Newsprint for Tomorrow, p. 233.

The uncertain and fluctuating supply of surplus bagasse would appear to be an unfavorable factor to be considered in any plan to establish a bagasse paper plant using this source of supply. It is also apparent that a plant relying on surplus bagasse as raw material would have to collect the product from a comparatively large territory, with an accompanying increase in cost over that for a plant using all the bagasse produced by one or more sugar mills.

LOCATION OF BAGASSE PRODUCTION IN CUBA

Sugarcane is grown throughout Cuba, although production is somewhat larger in the eastern than in the western part of the country. The location of all the active sugar mills in Cuba and of the ports through which sugar is exported is shown on the accompanying map.

More than half the sugarcane processed in 1950 came from the two eastern Provinces of Oriente and Camagüey, as compared with 12 percent from the western Provinces of Pinar del Rio and Habana.

Exports of sugar from Cuba by Provinces show approximately the same distribution as sugarcane production. In 1950 sugar was exported through 23 ports, the most important being Nuevitas.

Habana is by far Cuba's most important port of entry for imports.

Table II shows the quantity of sugarcane processed and the estimated quantity of bagasse produced by each of the 161 sugar mills in Cuba in 1950. The estimated production of bagasse varied from about 6,000 tons for the smallest mill to 161,000 tons for the largest. The average per mill for the entire country was 35,000 tons, varying from 24,000 tons in Santa Clara to 65,000 tons in Camagüey.

VALUE OF BAGASSE

Since most of the bagasse produced in Cuba is used for fuel in sugar mills, its value to the mills can be determined best by estimating the cost of using an alternate fuel. No alternate fuel is produced in Cuba in sufficient volume to be of importance in replacing bagasse.

Oil, all of which would need to be imported, appears to be the most promising fuel that might be used in Cuba in place of bagasse.

Available estimates [3] indicate that 1 ton of bagasse, dry basis, has about the same fuel value in a sugar mill as 2 barrels (84 gallons) of fuel oil.

The experience of one company in Cuba indicates that at current prices fuel oil delivered to a sugar mill in Cuba in tank-car lots costs about $3.46 per barrel, or $6.92 for enough oil to replace 1 ton of bagasse, dry basis.

In order to use fuel oil in place of bagasse, a sugar mill would necessarily incur certain expenses, in addition to the cost of the oil itself. These additional costs include items such as—

1. Installation of oil burners in mill furnaces.
2. Construction of oil-storage facilities.
3. Provision of railway tank cars or trucking facilities for moving oil from the port to the mill.
4. Altering bagasse carriers in the sugar mill so that bagasse can be moved to a baling machine or elsewhere, instead of being delivered to the furnaces

If bagasse is to be transported in bales, it is also necessary to provide baling equipment and labor to operate it. In addition, there will be certain expenses for storing and loading baled bagasse on railway cars or trucks.

The experience of one company in Cuba indicates that the cost of baling bagasse, including the movement of bales into and out of storage stacks, but excluding depreciation and interest on equipment, would amount to about $10.25 per ton.

The cost of substitute fuel plus the cost of baling, exclusive of capital costs, thus, is approximately $17.17 per ton of bagasse, dry basis.

Sufficient information is not available to make possible an estimate of the amount of the additional investment that would be needed at a sugar mill to enable it to use fuel oil and to bale its bagasse. However, because of the additional investment that would be required, it probably would not be feasible for a sugar mill in Cuba to sell its bagasse, except excess bagasse, without reasonable assurance of a satisfactory market over a period of years.

Uncertainty concerning the future relationship between the price of fuel oil and of newsprint no doubt increases the risk of making the new investments needed if paper is to be manufactured from bagasse in Cuba.

[3] Sugarcane Handbook, by Spencer and Meade; and The Industrial Utilization of Sugarcane Byproducts, by Walter Scott.

SUMMARY

1. A large quantity of bagasse is produced in Cuba, but the exact amount is unknown and can only be estimated. In past years the quantity has fluctuated widely because of variations in the production of sugar.

2. Comparatively little information is available concerning the quantity of excess bagasse, the amount in excess of that needed for fuel by sugar mills, produced in Cuba. However, it appears to fluctuate widely among mills and from year to year in the same mill.

3. Unfavorable factors that would affect the operation of a paper plant using only surplus bagasse are uncertainities in supply and the comparatively large area from which the material would have to be collected.

4. Bagasse is produced throughout Cuba, but production is somewhat concentrated in the eastern part of the country.

5. The output of bagasse varies widely among mills.

6. Under present conditions the operating costs of baling and storing bagasse, plus the cost of an alternate fuel, would amount to at least $17 per ton of bagasse, dry basis.

7. In order to convert to the use of fuel oil, sugar mills would have to invest in additional equipment, and would need a period of years in which to amortize the investment.

8. The fact that substitute fuels are not produced in Cuba, but must be imported, increases their cost.

TABLE I.—*Sugarcane harvested in Cuba and estimated production of bagasse, by years, 1935–51*

[In thousand tons]

Year	Sugarcane harvested	Estimated production of bagasse [1]	Year	Sugarcane harvested	Estimated production of bagasse [1]
1935	24,847	2,982	1944	45,314	5,438
1936	27,616	3,314	1945	30,224	3,627
1937	34,346	4,122	1946	36,859	4,423
1938	29,177	3,501	1947	52,584	6,310
1939	28,282	3,394	1948	54,270	6,512
1940	31,220	3,746	1949	45,999	5,520
1941	33,010	3,961	1950	46,916	5,630
1942	36,525	4,383	1951	53,104	6,372
1943	25,309	3,037			

[1] Assuming bagasse, dry basis, equals 12 percent of the weight of sugarcane harvested.

Source: U. S. Department of Agriculture.

TABLE II.—*Sugarcane ground and bagasse produced in Cuba in 1950, by provinces and mills*

[Thousand tons]

Province and mill	Sugarcane ground	Bagasse produced [1]
PINAR DEL RIO		
1. Andorra	269	32
2. Bahía Honda	136	16
3. El Pilar	260	31
5. La Francia	115	14
6. Mercedita	255	31
7. Niágara	107	13
8. Orozco	276	33
9. San Cristóbal	277	34
10. San Ramón	169	20
Total	1,864	224
Average	207	25
HABANA		
11. Amistad	265	31
12. Fajardo	146	18
13. Gómez Mena	523	63
14. Habana	141	17
15. Hershey	656	79
16. Josefita	122	15
17. Mercedita	399	48
18. Occidente	67	8
19. Portugalete	172	21
20. Providencia	323	38
21. Rosario	226	27
22. San Antonio	251	30
23. Toledo	523	63
Total	3,814	458
Average	293	35
MATANZAS		
24. Alava	381	45
25. Araújo	178	21
26. Australia	174	21
27. Carolina	167	20
28. Conchita	358	43
29. Cuba	592	71
30. Dolores	92	11
31. Dos Rosas	101	12
32. Elena	50	6
33. España	588	70
34. Guipúzcoa	256	31
35. Limones	105	13
36. Mercedes	248	30
37. Por Fuerza	306	37
38. Progreso	269	32
39. Puerto	49	6
40. San Ignacio	123	15
41. Santa Amalia	180	22
42. Santa Rita	148	18
43. Santo Domingo	190	23
44. Soledad	172	21
45. Tinguaro	380	46
46. Triunfo	104	12
47. Zorrilla	124	15
Total	5,338	641
Average	222	27
SANTA CLARA		
48. Adela	204	24
49. Amazonas	112	13
50. Andreita	232	28
51. Caracas	329	39
52. Carmita	103	13
54. Constancia A	347	41
55. Constancia E	170	20
56. Corazón de Jesús	159	19
57. Covadonga	215	25
60. Escambray	124	15
61. Fe	258	31
62. Fidencia	159	19
63. Hormiguero	274	33
64. La Vega	114	14
65. Macagua	127	15
66. Manuelita	239	29
67. María Antonia	55	7
69. Narcisa	281	34
70. Natividad	165	20
71. Nazábal	247	30
72. Nela	68	8
73. Angelita (Parque Alto)	141	17
74. Pastora	137	16
75. Perseverancia	353	42
76. Portugalete	144	17
77. Purio	131	16
78. Ramona	247	30
79. Reforma	224	27
80. Resolución	139	17
81. Resulta	264	32
82. San Agustín L	276	33
83. San Agustín R	263	31
84. San Francisco	105	13
85. San Isidro	274	33
86. San José	173	21
87. San Pablo	84	10
88. Santa Catalina	179	21
89. Santa Isabel	198	24
90. Santa Lutgarda	211	25
91. Santa María	228	27
92. Santa Rosa	163	20
93. Santa Teresa	258	31
94. Soledad C	233	28
95. Trinidad	190	23
96. Tuinucú	329	39
97. Ulacia	157	19
98. Unidad	168	20
99. Vitoria	240	29
100. Washington	293	35
101. Zaza	168	20
Total	9,955	1,194
Average	199	24
CAMAGUEY		
102. Adelaida	452	53
103. Agramonte	414	50
104. Algodones	416	50
105. Baragúa	743	89
107. Céspedes	310	37
109. Cunagua	604	72
110. Elia	469	56
111. Estrella	346	42
112. Florida	256	31
113. Francisco	697	84
115. Jaronú	1,065	128
116. Jatibonico	423	51
117. Lugareño	480	58
118. Macareño	404	48
119. Morón	1,343	161
120. Najasa	148	18
121. Patria	272	33
123. Punta Alegre	447	54
124. Santa Marta	295	35
125. Senado	595	71
126. Siboney	131	16
127. Stewart	984	118
129. Vertientes	1,008	121
130. Violeta	724	87
Total	13,026	1,563
Average	543	65

See footnotes at end of table, p. 123.

LOCATION OF

PORTS THROU

SUGARCANE GROUND BY PROVINCES - 1950

Province	Short Tons	Per Cent
Pinar Del Rio	1,863,955	3.97
Habana	3,813,619	8.13
Matanzas	5,338,329	11.38
Santa Clara	9,955,245	21.22
Camaguey	13,026,013	27.76
Oriente	12,921,332	27.54
Total	46,918,493	100.00

OF SUGAR MILLS IN CUBA AND

ROUGH WHICH SUGAR IS EXPORTED

SUGAR EXPORTS BY PROVINCES - 1950

Province	Per Cent
Pinar Del Rio	2.02
Habana	8.84
Matanzas	11.62
Santa Clara	21.80
Camaguëy	28.03
Oriente	27.69
Total	100.00

SUGAR EXPORTS BY PORTS
1950

Port	Per Cent
Nuevitas	15.47
Habana	8.84
Júcaro	8.79
Cardenas	8.06
Cienfuegos	7.46
Caibarien	6.13
Isabela de Sagua	5.81
Antilla	4.82
Puerto Padre	4.81
Santiago de Cuba	4.54
Guantánamo	4.18
Santa Cruz del Sur	3.77
Matanzas	3.56
Manzanillo	2.47
Manatí	2.21
Mariel	2.02
Preston	1.86
Tunas de Zaza	1.55
Banes	1.28
Casilda	0.85
Tánamo	0.66
Gibara	0.47
Niquero	0.39
Total	100.00

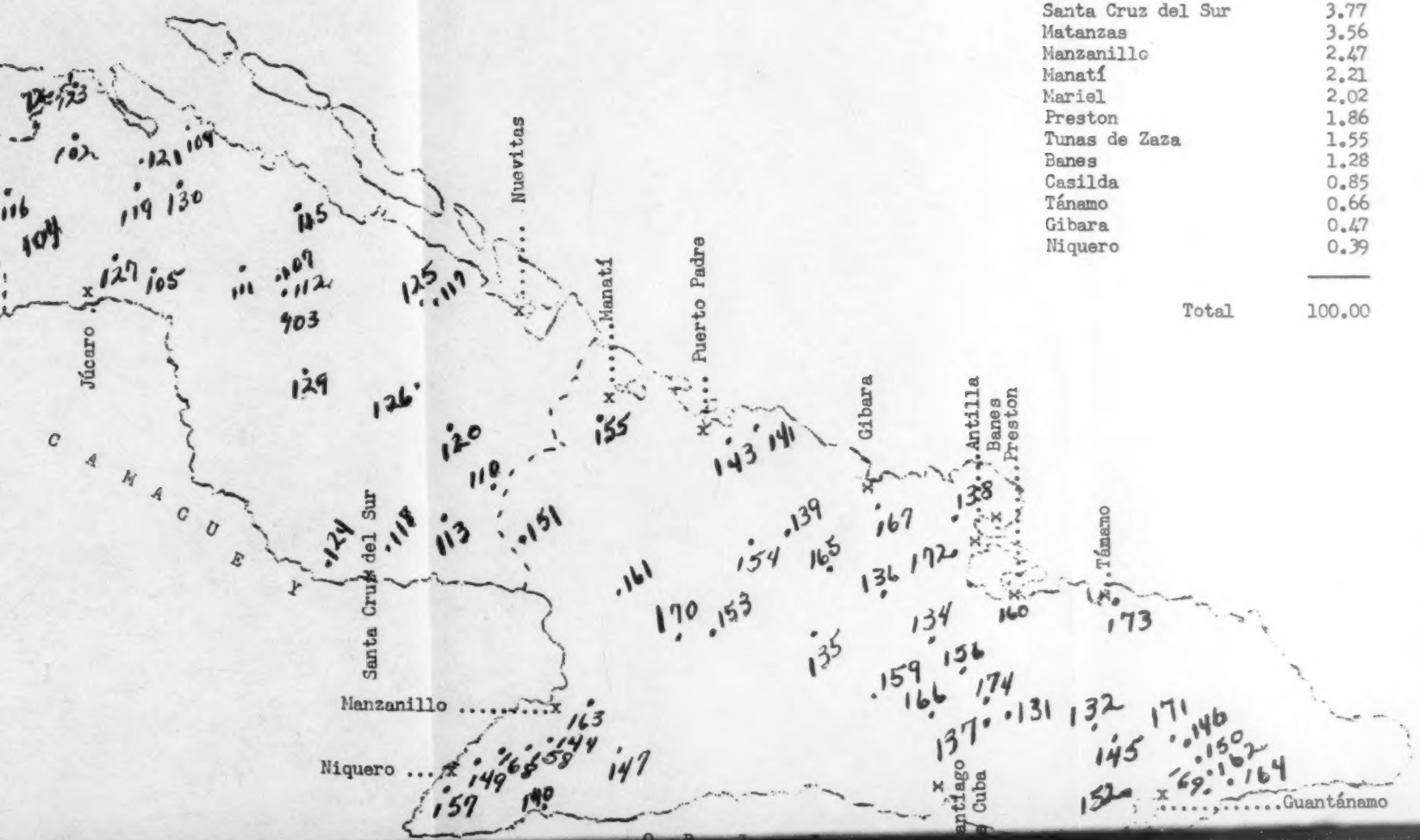


TABLE II.—*Sugarcane ground and bagasse produced in Cuba in 1950, by provinces and mills*—Continued

[Thousand tons]

Province and mill	Sugarcane ground	Bagasse produced [1]	Province and mill	Sugarcane ground	Bagasse produced [1]
ORIENTE			ORIENTE—continued		
131. Algodonal	113	14	159. Palma	491	59
134. Alto Cedro	351	42	160. Preston	774	93
135. América	417	50	161. Río Cauto	204	24
136. Báguanos	311	37	162. Romelié	164	20
132. Baltony (antes Almeida)	379	45	163. Salvador	116	14
137. Borjita	195	23	164. San Antonio	96	12
138. Boston	576	69	165. San Germán	693	83
139. Cacocum	188	23	168. San Ramón	168	20
140. Cape Cruz	148	18	166. Santa Ana	289	35
141. Chaparra	897	107	169. Santa Ceilia	81	10
143. Delicias	1,200	144	167. Santa Lucía	220	26
144. Dos Amigos	65	8	158. Santa Regina (Ofelia)	121	14
145. Ermita	179	21	170. Sofía	127	15
146. Esperanza	167	20	171. Soledad	224	27
147. Estrada Palma	240	29	172. Tácajó	332	40
149. Isabel (Beattie)	172	21	173. Tánamo	324	39
150. Isabel (Jamaica)	140	17	174. Unión	162	19
151. Jobabo	355	43			
152. Los Caños	168	20	Total	12,921	1,550
153. Mabay	176	21	Average	315	38
154. Maceo	177	21			
155. Manatí	963	116	Grand total	46,918	5,630
156. Miranda	592	71	Average	291	35
157. Niquero	166	20			

[1] Assuming bagasse, dry basis, equals 12 percent of the weight of sugarcane harvested.

NOTE.—Code numbers omitted from this table refer to mills listed in the Cuba Sugar Yearbook as no longer operating.

Source: Cuba Sugar Yearbook.

APPENDIX L

SUGARCANE BAGASSE IN THE CARIBBEAN AREA

(Reprinted from "The Industrial Utilization of Sugar Cane By-Products," by Walter Scott, Caribbean Commission, Central Secretariat, Kent House, Port-of-Spain, Trinidad)

So far as is known, no attempt has hitherto been made to present a composite picture of the sugarcane byproducts situation in the Caribbean area. Consequently, some difficulty has been experienced in ascertaining the quantities of byproducts obtained during the 1949 crop "at each factory in each island or territory," since the methods of factory control and of reporting factory data are not uniform throughout the area. Furthermore, where there has been a surplus of bagasse, some of the factories have not been in the habit of estimating the amount of the surplus. Now that attention has been focused on the potential value of each of the byproducts, it is to be hoped that, by the end of another crop, more accurate figures will be available so that a more complete picture may be obtained.[1]

For the principal territories part of the data given in tabular form was extracted from summaries of factory results for the 1949 crop, prepared and supplied by their respective sugar associations. Some figures, including tons of fiber and tons of green bagasse, were calculated from data contained in those summaries. A few columns have been left blank owing to insufficient information.

ANTIGUA

1949 crop

Factory	Cane, ground		Fiber, long tons	Green bagasse, long tons	Filter cake		Final molasses	
	Long tons	Percent fiber			Long tons	Percent of cane weight	Imperial gallons	° Brix
Antigua Sugar Factory, Ltd.....	154,046	16.88	26,003	50,300	4,412	2.86	639,565	90.2

Surplus bagasse and molasses.—According to the chairman of the Antigua Sugar Association, "In a normal year surplus bagasse should be between 2,000 and 3,000 tons, and production of molasses should amount to 875,000 gallons, of which 150,000 are disposed of locally."

[1] For assistance in assembling the data necessary for the preparation of this section of the report, I am indebted to the secretariat of the Caribbean Commission, to the British West Indies Sugar Association, and to personal friends.

BARBADOS

1949 crop

Factory	Cane, ground		Fiber, long tons	Green bagasse, long tons	Filter cake		Final molasses	
	Long tons	Percent fiber			Long tons	Percent of cane weight	Imperial gallons	° Brix
Andrews	81,782	13.6	11,122	22,164			(1)	89.1
Applewhaites	49,082	15.4	7,559	14,195			(1)	89.7
Bulkeley	120,548	14.6	17,600	34,135	2,930	2.43	(1)	92.5
Foursquare	40,960	17.0	6,963	13,165			(1)	94.3
Guinea	21,465	14.4	3,091	6,063			(1)	92.5
Haymans	53,541	15.8	8,459	16,717	755	1.41	(1)	90.4
Joes River	26,313	14.3	3,763	7,672			(1)	95.2
Lemon Arbor	49,715	16.1	8,004	15,517			(1)	91.9
Lower Estate	63,760	16.4	10,457	20,850			(1)	92.1
Porters	54,292	15.8	8,578	16,534	1,108	2.04	(1)	91.1
Searles	55,559	14.9	8,278	16,198	650	1.17	(1)	92.9
Haggatts	29,142	15.4	4,488	8,930	530	1.82	(1)	94.9
Swans	16,978	17.7	3,005	5,966	230	1.35	(1)	91.8
Three Houses	61,840	15.4	9,523	18,578			(1)	91.7
Warrens	48,312	15.9	7,682	15,413			(1)	89.1
Spring Hall	57,050	15.3	8,729	17,590			(1)	95.0
Totals and averages	830,339	15.33	127,301	249,685			(1)	

1 Figures not available.

NOTE.—The above figures were extracted or calculated from the Comparative Summary of Factory Results for the 1949 Crop, compiled by the Barbados Technologists Association. Figures for the spaces left blank were not included in this summary, which comprised the only information received from Barbados.

BRITISH GUIANA

1949 crop

Factory	Cane, ground		Fiber, long tons	Green bagasse, long tons	Filter cake		Final molasses	
	Long tons	Percent fiber			Long tons	Percent of cane weight	Imperial gallons	° Brix
Skeldon	133,630	14.98	20,018	40,400	2,646	1.98	747,206	
Port Mourant	157,663	13.76	21,694	42,900	4,588	2.91	739,243	
Albion	162,691	15.10	24,566	49,063	6,312	3.88	759,000	
Rose Hall	202,031	14.06	28,405	57,605	3,576	1.77	940,732	
Blairmont	188,951	14.64	17,414	34,156	7,974	4.22	983,627	
Enmore	226,584	17.28	39,153	76,366	10,921	4.82	1,122,754	
La Bonne Intention	160,232	14.26	22,849	46,460	4,679	2.92	784,609	
Ogle	93,014	15.08	14,026	28,607	3,302	3.55	391,898	
Houston							100,000	
Ruimveld							73,479	
Diamond	234,564	15.72	32,182	66,014	3,636	1.55	1,301,412	
Wales	67,257	14.71	9,893	22,000			301,859	
Versailles	69,161	13.82	9,558	20,021	1,681	2.43	344,900	
Leonora	148,291	13.87	20,568	41,822	2,743	1.85	613,125	
Uitvlugt	119,953	15.61	18,725	36,608	3,023	2.52	866,489	
Totals and averages	1,964,022	14.20	279,051	562,022	55,081	2.80	10,070,333	

Surplus bagasse.—The following information was supplied by the British Guiana Sugar Producers Association:

"Of the 15 factories operating in British Guiana in 1949, only 2 had a surplus of bagasse over that required as fuel, the total of which is estimated to have been about 8,000 tons.

"It must be pointed out, however, that conditions in 1949 can by no means be taken as an indication of those in the future. In the first place the majority of the factories are at present undergoing modification, one of the effects of which will be to improve fuel economy; and secondly, there has recently been an improvement in the supply of cane following upon the introduction of certain incentives to cane cutters, resulting in fewer out-of-cane stoppages and a lower fuel consumption.

"As a consequence it is very probable that in the very near future nearly every factory will produce surplus bagasse; already, for instance, the accumulation of bagasse at the new Uitvlugt factory at times reaches embarrassing proportions. It is impossible at this stage to give a reliable indication of what the future surplus is likely to be, but it is estimated that, if the present trend continued, some 50,000 to 75,000 tons should be available annually."

Final molasses.—According to figures received from the British Guiana Producers Association, the utilization of molasses during 1949 was approximately as follows:

		Imperial gallons
Used for rum		5, 821, 455
Sold	4, 112, 279	
Less [1]	117, 348	
		3, 994, 931
Used on fields		41, 279
Used for stock		274, 810
Ditched		70, 595
Total		10, 203, 070
Less: Carried over from 1948		132, 737
Produced in 1949		10, 070, 333

[1] Sold to other distilleries and reported by them as "used for rum."

GUADELOUPE

A communication from the Government of Guadeloupe to the Secretariat of the Caribbean Commission states that practically all bagasse produced at the various factories was used as fuel. Without quoting figures, it mentions that there were, in 1949, important quantities of molasses on hand as a consequence of the rum crisis but that, normally, all molasses produced would be used by the distilleries for the manufacture of rum.

JAMAICA

1949 crop

Factory	Cane, ground		Fiber, long tons	Green bagasse, long tons	Filter cake		Final molasses	
	Long tons	Percent fiber			Long tons	Percent of cane weight	Imperial gallons	°Brix
Monymusk	308,989	15.11	46,688	91,455	8,621	2.79	[2]	92.1
Frome	391,930	12.58	49,305	96,431	10,308	2.63	[2]	90.0
New Yarmouth	131,250	15.06	19,766	37,678	3,846	2.93	[2]	90.4
Caymanas	95,065	13.37	12,710	23,913	2,443	2.57	[2]	90.3
Innswood	77,437	11.84	9,168	17,282	1,936	2.50	[2]	86.6
Gray's Inn	131,591	15.68	20,633	38,945	3,000	2.28	[2]	88.5
Barnett	35,004	12.69	4,442	8,538	588	1.68	[2]	85.4
Sevens	90,373						[2]	
Jamaica Sugar Estates	157,901	14.86	23,464	44,753	2,290	1.45	[2]	84.3
United Estates	66,123	11.81	7,809	15,390	767	1.16	[2]	87.7
Vale Royal	45,405	14.98	6,802	12,951	745	1.64	[2]	81.3
Richmond	26,523	13.82	3,665	7,301	249	.94	[2]	86.7
Serge Island	81,125	14.02	11,374	20,820	990	1.22	[2]	85.6
Bernard Lodge	163,861	12.82	21,007	41,747	3,392	2.07	[2]	92.7
Monymusk (Old)	96,623	15.20	14,687	29,943	1,768	1.83	[2]	91.4
Rose Hall	25,765	16.71	4,305	8,198	242	.94	[2]	83.0
Appleton	40,888	11.90	4,866	9,372	409	1.00	[2]	81.8
Holland	21,764				202	.93	[2]	84.6
Raheen								
Long Pond	32,588	14.61	4,761	9,300	362	1.11	[2]	81.8
Worthy Park	53,002	15.26	8,088	16,333	1,118	2.11	[2]	90.3
Kew	21,040						[2]	
Hampden	65,672	14.63	9,608	19,289	952	1.45	[2]	88.0
Green Park	16,134	16.43	2,651	5,309	113	.70	[2]	82.4
Ironshore	12,487	11.76	1,468	3,027	181	1.45	[2]	84.5
Liandovery	19,391	16,12	3,126	6,311	157	.81	[2]	83.3
Bog							[2]	
Cambridge							[2]	
Totals and averages	2,207,931	[1] 14.00	290,393	564,286	44,679	2.02	10,442,300	88.4

[1] Cane tonnages ground at Sevens and Holland omitted in calculating average fiber percent in cane owing to incomplete data.
[2] Figures not available.

NOTE.—Total gallons of final molasses made obtained by calculation from other figures submitted for the 1949 crop.

Surplus bagasse.—No estimates of surplus bagasse are available for the 1949 crop. According to the manager of the Sugar Manufacturers Association (of Jamaica), Ltd.: "the estimated quantity of surplus bagasse available at the end of this (1950) crop is 10,800 tons at six factories, Frome being responsible for 6,000 tons. The other 17 factories will have no surplus bagasse. The same six factories anticipate 19,000 tons available at the end of the 1951 crop, of which Frome accounts for 10,000 tons."

Final molasses.—The quantities of molasses produced by each factory are not given in the summary of factory results for the 1949 crop; no useful purpose would be served by calculating the output of only those factories which have supplied sufficient data to their association. However, by calculations made from the data available, I have estimated the total output of molasses at 88° Brix to be 10,442,300 imperial gallons.

According to the final distillery report of the SMA (of Jamaica) Ltd. for the 1349 crop, 18 distilleries converted 7,532,930 imperial gallons of molasses at 88° Brix into rum, and 117,694 gallons into alcohol. Molasses reported as utilized by the distilleries amounted, therefore, to 7,650,624 Imperial gallons, or 73.25 percent of the total production. As three of the distilleries listed by the association did not report their results, it may be assumed that from 75 to 80 percent of the final molasses produced in Jamaica during 1949 was utilized for rum or alcohol manufacture.

No information has been received regarding quantities of molasses sold or used for feeding livestock.

MARTINIQUE

The following rough estimate of byproducts of the Martinique factories was supplied by the Government of that island to the Caribbean Commission:

1.	Total production of bagasse, about	metric tons	125, 000
2.	Surplus of bagasse after meeting fuel requirements	do	8 to 10,000
3.	Total production of molasses	liters	26, 000, 000
4.	Surplus of molasses after the manufacture of rum [1]	do	9, 000, 000
5.	Quantity of filter cake (used as fertilizer)	tons	5, 000

[1] This surplus, due to the rum crisis, is exceptional.

PUERTO RICO

1949 crop

Central	Cane ground		Fiber	Green bagasse	Filter cake		Final molasses	
	Short tons	Percent fiber	Short tons	Short tons	Short tons	Percent of cane weight	United States gallons	°Brix
Rio Llano	135, 053	14. 58	19, 691	40, 054	5, 130		664, 000	90. 5
Los Canos	306, 928	12. 19	37, 415	86, 447	11, 663		1, 409, 000	88. 7
Cambalache	490, 718	15. 14	74, 295	156, 245	18, 647		2, 400, 000	90. 5
Plazuela	298, 828	15. 56	46, 498	96, 749	11, 355		1, 685, 000	93. 0
Monserrate	242, 665	14. 52	35, 235	77, 884	9, 221		1, 160, 000	89. 6
San Vincente	447, 724	15. 27	68, 367	148, 270	17, 014		2, 283, 000	90. 7
Constancia	294, 939	11. 71	34, 537	75, 908	11, 208		1, 507, 000	92. 4
Juanita	335, 689	14. 52	48, 742	104, 016	12, 756		1, 631, 000	91. 4
San Jose	193, 683	14. 73	28, 530	59, 349	7, 360		988, 000	89. 9
Victoria	210, 383	16. 74	35, 218	72, 839	7, 995		976, 000	89. 2
Canovanas	374, 840	15. 25	57, 163	119, 939	14, 244		1, 743, 000	90. 4
North Zone	3, 331, 450	14. 58	485, 691	1, 037, 700	126, 593	3. 80	16, 446, 000	90. 7
Guanica	951, 209	12. 74	121, 184	254, 909	36, 146		6, 078, 000	87. 9
San Francisco	58, 654	13. 84	8, 118	18, 221	2, 229		284, 000	92. 2
Rufina	276, 267	16. 21	44, 783	92, 644	10, 498		1, 812, 000	90. 2
Mercedita	605, 069	12. 49	75, 573	160, 930	22, 993		3, 364, 000	95. 1
Constancia	102, 950	13. 97	14, 382	31, 150	3, 912		575, 000	87. 5
Cortada	198, 736	12. 73	25, 299	51, 853	7, 552		1, 240, 000	85. 8
Aguirre	610, 627	11. 71	71, 504	151, 428	23, 204		3, 627, 000	85. 5
Machete	173, 649	13. 81	23, 981	49, 578	6, 599		827, 000	86. 1
Lafayette	334, 483	13. 18	44, 085	91, 538	12, 710		1, 512, 000	90. 1
Guamani	83, 740	13. 70	11, 472	23, 228	3, 182		446, 000	86. 3
South Zone	3, 395, 384	12. 97	440, 381	925, 476	129, 025	3. 83	19, 765, 000	89. 7
Fajardo	647, 019	16. 87	109, 152	218, 470	24, 587		3, 688, 000	89. 0
Pasto Viejo	451, 055	14. 36	64, 771	140, 532	17, 140		2, 702, 000	85. 4
El Ejemplo	173, 522	12. 38	21, 482	41, 547	6, 594		816, 000	87. 5
Roig	350, 153	12. 31	43, 104	88, 818	13, 306		1, 576, 000	87. 0
East zone	1, 621, 749	14. 71	238, 509	489, 367	61, 627	3. 80	8, 782, 000	87. 4
Coloso	376, 613	13. 95	52, 538	115, 518	14, 311		1, 913, 000	89. 2
Rochelaise	104, 379	12. 63	13, 183	28, 640	3, 966		668, 000	87. 8
Eureka	298, 174	14. 63	43, 623	96, 001	11, 331		1, 685, 000	89. 8
Igualdad	407, 801	12. 78	52, 117	110, 698	15, 496		2, 512, 000	85. 9
West zone	1, 186, 967	13. 60	161, 461	350, 857	45, 104	3. 80	6, 778, 000	88. 0
Plaza	364, 511	14. 37	52, 380	107, 138	13, 851		1, 910, 000	90. 4
Soller	123, 979	14. 48	17, 952	35, 290	4, 711		549, 000	93. 6
Pellejas	66, 934	12. 51	8, 373	17, 582	2, 543		332, 000	88. 7
Santa Juana	403, 899	13. 94	56, 304	118, 458	15, 348		2, 254, 000	89. 9
Juncos	365, 158	13. 42	49, 004	104, 175	13, 876		1, 965, 000	87. 2
Cayey	138, 204	13. 44	18, 575	40, 467	5, 252		694, 000	87. 8
Central zone	1, 462, 685	13. 85	202, 588	423, 110	55, 581	3. 79	7, 704, 000	89. 4
Grand total	10, 998, 235	13. 90	1, 528, 630	3, 226, 510	417, 930	3. 80	59, 465, 000	

Surplus bagasse.—Particulars have been sought from individual factories in Puerto Rico, but they are not yet available.

Final molasses.—Information is not yet available regarding the disposal of 59,465,000 gallons of molasses produced during the 1949 crop. Figures supplied

by the Sugar Producers Association of Puerto Rico show that, during the 1948 crop, 54,962,084 gallons of final molasses were produced, of which 10,152,084 gallons were used in the country for the manufacture of rum and alcohol and for feeding livestock. The surplus of 44,810,000 gallons was exported to the United States. It is understood that the exportable surplus of molasses is subordinated to the needs of the rum market and varies accordingly.

ST. KITTS

1949 crop

Factory	Cane, ground		Fiber, long tons	Green bagasse, long tons	Filter cake		Final molasses	
	Long tons	Percent fiber			Long tons	Percent of cane weight	Imperial gallons	° Brix
St. Kitts (Basseterre) Factory	298,414	13.58	40,525	76,897	9,556	3.20	1,276,150	87.6

Surplus bagasse.—The chemist's report records that 19,919 long tons of surplus bagasse were baled during the 1949 crop. It is understood that no profitable utilization of this large surplus has, so far, been successfully developed.

As the St. Kitts Sugar Association has supplied no information, the actual method of disposal of the molasses or of the surplus bagasse is not known.

SURINAM

Reports received by the Secretariat of the Caribbean Commission from sugar factories in Surinam, with reference to byproducts obtained during the 1949 crop, may be summarized as follows:

1. Marienburg:
   Bagasse: No surplus.
   Molasses: 1949 production, 917,770 liters; 1949 surplus, 115,580 liters.
   The anticipated output of molasses for the 1950 crop was estimated to be barely sufficient for the production of rum and methylated spirits for local consumption.
   Filter press cake, 5,255 quintals (equivalent to 525.5 metric tons).
2. Alliance:
   Bagasse: No surplus.
   Molasses: 1949 production, 333,445 liters.
   The molasses is sold locally for feeding stock. There is virtually no surplus.
   No filter presses and, consequently, no press cake.

TRINIDAD

1949 crop

Factory	Cane, ground		Fiber, long tons	Green bagasse, long tons	Filter cake		Final molasses	
	Long tons	Percent fiber			Long tons	Percent of cane weight	Imperial gallons	° Brix
Usine								
St. Madeleine	489,300	14.43	70,606	146,637	15,364	3.14	2,477,755	87.3
Woodford Lodge	207,784	13.47	27,988	60,527	4,343	2.09	1,091,000	88.1
Waterloo	119,359	14.56	17,379	36,335	1,480	1.24	568,874	85.5
Brechin Castle	294,160	14.58	42,889	89,278	7,060	2.40	1,688,248	89.7
Esperanza	115,056	14.54	16,729	34,415	3,314	2.88	566,781	87.0
Orange Grove	101,930	13.90	14,168	30,528	1,142	1.12	435,000	85.2
Reform	63,866	14.94	9,542	19,188	1,234	1.93	258,543	89.1
Forres Park	46,792	14.18	6,635	12,638	833	1.78	230,755	88.3
Totals and averages	1,438,247	14.32	205,936	429,546	34,770	2.42	7,316,956	87.8

Surplus bagasse.—No sugar factory in Trinidad, given favorable grinding conditions, requires supplementary fuel, and most factories normally have a surplus of bagasse over fuel requirements. The three largest have a considerable surplus. However, with the exception of one factory which exports its surplus bagasse, the general practice has been to consume as much bagasse as possible in order to reduce to a minimum the useless surplus.

According to reliable sources, the total surplus bagasse produced in Trinidad during the 1949 crop amounted to approximately 36,000 long tons fresh from the mills. Had there been sufficient inducements to practice fuel economy and save all the bagasse possible, I believe that this total could have been increased to at least 50,000 tons.

Final molasses.—The disposal of molasses made during the 1949 crop was as follows:

	Imperial gallons
Used in distilleries	4, 507, 051
Used for stock and fertilizer	632, 160
Available for export	2, 177, 745
Total production	7, 316, 956

VIRGIN ISLANDS OF THE UNITED STATES

Figures forwarded to the Secretariat of the Caribbean Commission give the following estimates of the Virgin Islands Corporation regarding byproducts:

Bagasse production.—22,500 short tons, used as fuel except for a small quantity utilized in cattle feed.

Molasses production.—375,000 United States gallons, sold for the manufacture of rum, less a small quantity used in cattle feed.

Filter cake.—About 2,025 tons used in the fields as soil amendment.

APPENDIX M

[Reprinted from Paper Trade Journal, May 2, 1952]

LOUISIANA SUGARCANE BAGASSE

By Arthur G. Keller, professor, chemical engineering, Louisiana State University

Bagasse has attracted considerable attention of late as a possible raw material for the production of certain types of pulp for the paper industry. Interest stems from the ever-increasing demand for paper products plus the difficulties in obtaining pulpwood in the quantities needed to meet current and anticipated demands. In most proposals for utilizing bagasse, little or no information has been presented on its probable cost to the pulp mill. Data on production, costs, location of producers and probable supply are submitted in this discussion.

WHAT IS BAGASSE?

Bagasse is the fibrous residue obtained when sugarcane is processed to extract its sucrose content. As produced, the material will vary in color from a grayish white to a very dark-gray-green depending on the variety of cane ground and its freedom from adherent foreign material, such as soil and trash. The material is nonhomogeneous in size, varying from a dust, which will pass a 60-mesh screen, to particles around 6 inches long by ⅜ inch in cross section. Usually about 97 percent of the ordinary material will pass a 1-inch-square opening. The analysis on an "as produced" basis is about the following:

	Percent
Moisture	49
Fiber	45
Soluble solids	6

Fiber is by definition the constituent which is not soluble in water. It is usually a mixture of celluloses plus a small amount of insoluble ash. Soluble solids are principally sucrose, glucose, and fructose. Fiber has two major constituents, the true fiber, which is found in the rind of the cane, and in the fibrovascular bundles which are scattered through the stalk. The fiber length of this material ranges from 1 to 4 millimeters. The other major constituent is parenchyma or pith. In the living cane plant, this material constitutes the walls of the cells in which the sugar-bearing juices are stored. Chemically, it is cellulose just as is the fiber fraction but the pith does not have a fibrous structure and has no fiber length or strength. Separation of the pith from the fiber fraction greatly improves the pulping characteristics of the fiber. This separation has been the subject for study over many years and both chemical and mechanical methods have been suggested.

PRESENT USE

The use of bagasse as a raw material for the production of various types of paperlike products has occupied the attention of inventors and promoters for almost a century in this country alone. Despite this effort, bagasse is not commercially utilized in the continental United States except in the production of wallboard, agricultural mulch, and as fuel. It has found limited use for paper production in some areas of the world where pulpwood is scarce or nonexistent and currency problems make the importation of pulp or paper difficult and costly. Limited use of bagasse in paper and pulp production has been reported from the following areas: Argentina, Brazil, Colombia, Formosa, Peru, and the Philippines. Products reported range from bank-note paper to corrugating medium.

SEPARATION IMPROVES BAGASSE

Production of a clean, high grade pulp of uniform quality from bagasse is obviously difficult but not impossible of achievement. The irregular nature of the raw material makes a preliminary screening and cleaning operation advisable

to remove soil, come pith, and solubles. Sizing also aids in subsequent pulping operations. These operations are made difficult by the fact that bagasse, as produced, is damp and will quickly blind most screens. Wet screening has also proven difficult and unsatisfactory. Chemical cleaning and/or separation methods are rendered difficult by the chemical similarity of the materials to be separated. Several mechanical cleaning or separation methods have been advocated and some of these appear to offer considerable promise. Mechanical removal of pith and extraneous material from bagasse fiber to be satisfactory must be low in cost, efficient, and must not involve an appreciable loss of fiber in the separated pith. The separation can be accomplished manually by rubbing the bagasse together in the hands thus loosening the soft pith from the tougher fibers. Use of this idea has been advocated by inventors who have proposed rod mills, cage mills, and hammer mills in various designs and arrangements to bring about the necessary rubbing action. Power consumption of most of these schemes has been excessive and fiber losses with the pith relatively high. Wet separation, using the hydropulper, is being tried on a pilot-plant scale in Hawaii. A separation involving the use of a modified hammer mill and water is being operated on a pilot scale at Louisiana State University. Both of the latter processes yield an excellent fiber with very good pulping qualities. Their ultimate value will be determined by three factors as yet undetermined. These are:

1. Cost of the operation.
2. Development of satisfactory procedures for the storage and preservation of the clean separated fiber.
3. Development of an economic outlet for the separated pith fraction.

Bagasse on the bone-dry basis will average 65–70 percent fiber, and the balance is pith.

Bagasse fiber, when separated from the pith fraction, has been pulped using modifications of any of the following processes: soda, sulfate, and lime. It pulps readily with mild treatment and yields a very light colored pulp. Pulping does not appear to offer any serious problems with the material either as to technology or cost. Pulp usage is another problem. Present indications are that it will find its broadest field in blends with other pulps rather than as the sole component of any grade of paper.

The separated pith fraction has been suggested as an absorbent for use in animal feeds. Cost and low bulk density appear to be serious deterrents to its extensive application in this field. Other agricultural residues are available throughout the country, and while not as good absorbents as bagasse pith, offer the advantage of cheapness and in some cases higher food value. If the bagasse separation is made at the sugar mill, the pith may be dewatered and used for fuel as one possible solution of this problem.

STORAGE, A PROBLEM

Bagasse is a material with a very low bulk density, about 10 pounds per cubic foot as produced. Since about one-third of the weight of the cane ground is recovered as bagasse, the physical volume of the production makes its removal from the mill site imperative. Fortunately, with properly designed furnaces, bagasse is a good low grade fuel and the bagasse production of a modern sugar factory is adequate to supply the entire fuel requirements of the plant. Probably 95 percent of all the bagasse produced in the world is used as fuel at the factory in which it is produced. Where bagasse production exceeds fuel requirements the mill may either operate its furnaces at a lower efficiency or the excess may be discharged onto outdoor piles and burned. Under conditions prevailing in Louisiana, 1 ton (2,000 pounds) of average quality bagasse has a fuel value of 6,000,000 B. t. u. or 6 M. c. f. of 1,000 B. t. u. natural gas.

In most areas cane sugar production is a seasonal operation. In Louisiana the campaign usually lasts about 75 days. In the West Indies the campaign may extend from 120 to 150 days. In Hawaii where sugarcane is grown under irrigation, the grinding season extends over the entire year. Because bagasse production is usually seasonal any plan for its use must usually include provision for storage during the campaign of enough bagasse to last until the next season. Equipment and techniques have been developed in Louisiana for bagasse storage in connection with its use in the production of building and insulating board.

BALING BAGASSE

The low bulk density of bagasse makes it necessary that it be baled to facilitate storage and handling and to reduce the volume of storage space needed. Baling

is done on a machine which is a heavily reinforced and enlarged version of the conventional hay baler. The bales, as made, weigh around 250 pounds and measure 17 by 21 by 30 inches long. A single baling press has a capacity of about 200 tons of bagasse per 24-hour day. The bales as produced are moved by tram car and standard-gage railroad to a storage area located at a safe distance (firewise) from the sugar factory. At the storage site the bales in groups of six are lifted from the cars with a special type of tongs or grab and are stacked according to a definite pattern in piles which are about 66 feet wide by 100 feet long by 25 feet high. The bales are arranged so that air can circulate freely through the stack to remove the heat of fermentation and speed up the drying operation. As the material is being stacked, each tier of bales is sprinkled with powdered boric acid to reduce mold growth and aid in preservation. The completed stacks are covered with corrugated iron sheeting to keep out rain. These sheets are reused from year to year.

Baling stations for bagasse are relatively expensive to build, operate, and maintain. To keep such costs to a minimum, most bagasse purchase contracts are effected with mills which have a large annual volume of cane production, usually 100,000 tons or more. Actually, there is little difference in the initial cost of a station to process 10,000 tons fiber and one to handle 30,000 tons of the material. Currently, baling station, including the necessary conveying systems, yards, switch tracks, loading cranes, and living quarters, are costing around $150,000 and more for a size adequate to handle 15,000 tons fiber per season.

Stored bagasse loses moisture and will, after several months' storage, dry out to about 25 percent moisture content. The sugars content of fresh bagasse makes it an excellent medium for growth of numerous types of micro-organisms. Within a few hours after production, the sugars are under vigorous attack by several groups. Under proper storage conditions attack by micro-organisms causes the material to heat sufficiently to drive off a large part of the moisture present. The end product of fermentation under such conditions is a mixture of acetic, butyric, and related acids. Ordinarily the bagasse is relatively sterile after this reaction and may be kept in outdoor storage piles for one or more years. When properly baled and stacked the bagasse can be kept for several years without serious loss. Field losses, usually the lower tier of bales in the stack, will ordinarily average about 5 percent of the original fiber stored. The stored bagasse is moved from the stacks to railroad cars or barges with a traveling crane equipped with a special type grab.

COST AS A RAW MATERIAL

Bagasse fiber is frequently referred to as a waste material with the inference that it is available practically for the asking. The actual cost of bagasse fiber based on 1950 experience is about as follows:

	Per ton bonk-dry fiber [1]
Purchase price of bagasse	$2.50
Baling, stacking, and covering bagasse in field	6.00
Loading costs, storage to railroad cars	.50
Total cost, f. o. b. cars at point of origin	9.00

[1] Fuel value plus a slight bonus. Based on gas at 16⅔ cents per million B. t. u's.

To this cost must be added freight from the sugar factory to the point at which the bagasse is used. Railroad rates on the material average about $1.25 per ton per 100-mile haul. Barge rates average around $1 per ton per 100 miles.

During the current year experimental shipments of stored bagasse to pulp plants located along the upper Mississippi River have been made by rail and by barge. The published barge rate on bagasse from New Orleans, La., to a point just north of St. Louis is $5.61 per ton. Rail rates to this same area average slightly higher. While intrastate bagasse shipments are handled in open gondola cars, it has been necessary to employ closed cars for interstate shipments. This increases the cost of loading and unloading the bagasse over similar costs using open cars. The use of bagasse as a raw material for the paper industry does not appear feasible except in the immediate area of production.

PRODUCTION VOLUME

Bagasse production in Louisiana will average 1,500,000 tons per season of which about 750,000 tons is fiber. This bagasse is produced by 54 separate

factories located in the 20 southern parishes (counties) of Louisiana. The bagasse production of 11 mills is sold under long-term contracts for the production of wall board. The volume thus used totals about 210,000 tons of fiber per season. Four mills produce dehydrated bagasse which is used for animal and poultry litter and agricultural mulch. This group accounts for an additional 65,000 tons of fiber. The balance of approximately 475,000 tons fiber per season is burned at the factories for fuel. As auxiliary fuel these mills for the most part have available natural gas which is currently costing about 17 cents per million B. t. u.

AREAS OF PRODUCTION

Bagasse in Louisiana is produced by some 54 sugar mills located in the 20 southern parishes of the State. Production capacity of the mills in tons of fiber per season varies from a minimum of 4,000 tons to a maximum of 36,000 tons with the average being around 12,000 tons. All mills are served by railroads, improved highways, and in some cases by navigable bayous or canals. Major concentrations of mills are along three streams.

Seventeen mills are located along the Mississippi River, four being on the east bank, and thirteen along the west bank. None of these mills are able to use the river for the transportation of their products because of the wide variations in river level coupled with the high cost of dock or wharf facilities. East bank mills are served by the Illinois Central Railroad while those on the west bank are served by the Texas & Pacific or the Missouri Pacific Railroads. One mill on the east bank, Reserve, processes its bagasse to a salable product, all other east bank plants use their bagasse, some 30,000 tons fiber as fuel.

The 13 mills on the west bank of the Mississippi produce some 195,000 tons of fiber of which some 70,500 tons is sold under long-term contracts for wall board production. Mills which are under contract to sell their fiber are the largest in the group and are located 70 miles or less from New Orleans. The 10 mills which still use bagasse as fuel produce on the average 12,500 tons fiber each.

Along Bayou Lafourche, a distributary of the Mississippi River, are located 12 relatively large sugar mills with an aggregate production of some 200,000 tons of fiber. The production of 7 of the 12 mills, some 132,000 tons, is sold either for wallboard production or as agricultural mulch and litter. The outlet of Bayou Lafourche from the Mississippi River was dammed some 50 years ago so that the stream is now stagnant with very little change in level. At one time it was navigable for barge traffic for its entire length. Today it is virtually unused for water transport except along the lower reaches where only 3 of the 12 mills are located. The Bayou Lafourche group of mills are served by two railroad systems, the Texas & Pacific and Southern Pacific.

The third large group of mills is located west of the Atchafalaya and along Bayou Teche. There are 13 mills in this group with an aggregate fiber production totaling 198,000 tons per season. Only three mills in this group are selling bagasse at this time and their sales account for only 50,000 tons or one-fourth of the total available. The Teche is navigable by commercial barges from its mouth to a point just south of St. Martinville. Locks in the stream at that point restrict traffic in the upper reaches to very small barges. Since the Teche is tidal along its lower range, the water level is quite constant and barge shipments are quite practical from at least 9 of the 13 mills in the group. The mills are also served by the Southern Pacific and Missouri Pacific Railroads.

The Teche is connected to the Intracoastal Waterway which extends from Texas to Florida. Through this waterway, it is possible to move bagasse by barge to or from the lower Bayou Lafourche, and the bayou and canal system of the coastal parishes.

There are 12 factories located in areas other than the 3 just described. These mills produce about 135,000 tons fiber per year of which 40,000 tons are already being sold. Of the remaining production, about 20,000 tons is produced by mills located adjacent to navigable bayous or canals through which the fiber could be moved to the Teche area.

The Teche area offers the largest concentration of bagasse fiber now available for pulping purposes in Louisiana. This totals about 110,000 tons fiber per season at this time. This figure includes only fiber which can be handled by bulk shipment in barges direct from mills to a central processing plant. An additional 90,000 tons of fiber is available in the area but it would have to be moved by rail rather than water shipment.

The second largest concentration of bagasse is along the west bank of the Mississippi River from White Castle, La., north to New Roads, La. The fiber

in this area could be concentrated by rail or trucks at a point along Bayou Plaquemine which is navigable and which is open to the Mississippi River through locks. The maximum haul involved would be 35 miles but the average would be around 15 miles.

SUMMARY

To summarize, sugarcane bagasse is produced in Louisiana during a 75-day operating season at the annual rate of 750,000 tons fiber per season. Of this total, about 200,000 tons is used for the production of wallboard and agricultural mulch while the balance is burned as fuel by the sugar mills.

Bagasse has excellent possibilities as a raw material for the production of pulp for use in the paper and paperboard industry. Removal of the pith fraction and extraneous material from fiber fraction greatly improved the pulping characteristics of the latter. Several promising separation processes are now undergoing pilot-plant investigation.

Seasonal production of bagasse plus the need for year-round operation of pulp facilities makes storage of bagasse imperative. Techniques for the handling and storage of bagasse have been developed in Louisiana over the past quarter century.

Bagasse is not a cheap raw material. Current cost of fiber delivered to the user is around $11 per ton on a bone-dry basis for users located in the Louisiana area. At least 75 percent of this cost is for baling, storage, and transport of the fiber.

Louisiana production is concentrated in three major areas located along the Mississippi River, Bayou Lafourche, and Bayou Teche. The major tonnage of available bagasse is in the latter area. This area also offers cheap and convenient water transportation which is largely lacking in the other areas.

The second largest concentration of available bagasse is along the west bank of the Mississippi River centered around Plaquemine, La. This bagasse could be moved by rail or truck with an average haul of around 15 miles.

Utilization of bagasse as a raw material for pulp production appears feasible only with a plant located in the producing area so as to minimize costs of handling and transport.

Appendix N

[Reprint]

THE UTILIZATION OF SUGAR CANE BAGASSE FOR PAPER, BOARD, PLASTICS, AND CHEMICALS

Second Edition

An Annotated Bibliography

Compiled by Clarence J. West, The Institute of Paper Chemistry, Appleton, Wisconsin

TECHNOLOGICAL REPORT SERIES, NO. 8

(Revised edition of Scientific Report No. 3)

Sugar Research Foundation, Inc., New York, February 1952

Introduction

The following bibliography on the utilization of sugar-cane bagasse for pulp, paper, board, plastics, and the manufacture of chemicals was compiled by The Institute of Paper Chemistry for the Sugar Research Foundation, Inc.

The subject matter is divided into three sections: the use of bagasse as a source of pulp, paper, and board; its use in the manufacture of plastics; and miscellaneous chemical studies. No attempt has been made to include analytical methods or the utilization of bagasse as a fuel, fertilizer, etc.

In so far as the facilities of the library of The Institute permitted, the abstracts were prepared from the original article or patent. When the original was not available, abstract journals were used as source material. For completeness, certain articles have been included without abstracts; in many cases, these articles appeared before 1920, are anonymous, and probably would not add greatly to the general scientific and technical picture.

It is not claimed that this bibliography is complete. It is possible that certain articles have been overlooked because their titles did not indicate that they were concerned with bagasse or because the abstract journals did not carry a reference to bagasse. However, it is believe that all the important references are included up to July 1951.

The abbreviations used throughout this work are those adopted by Chemical Abstracts. In addition, the following abbreviations of abstract journals are used:

B. A., B. C. A., or B. C. P. A. British Abstracts, British Chemical Abstracts, or British Chemical and Physiological Abstracts.

B. I. P. C. Library Notes (Bulletin) of The Institute of Paper Chemistry.

C. A. Chemical Abstracts.

J. Soc. Chem. Ind. Journal of the Society of Chemical Industry (London). Includes Chemistry and Industry, Transactions, and British Chemical Abstracts B.

T. S. Technical Section of the Paper Trade Journal (the continuous pagination of the Tropical Section is used).

Auszüge. Auszüge aus der Literature der Zellstoff- und Papier-fabrikation. (This is a reprint of the abstracts originally appearing in Der Papier-Fabrikant.)

Clarence J. West.

Foreword

This edition of our earlier Scientific Report No. 3 now revised to July 1951 is being issued in the subsequently initiated Technological Report Series, in which it properly belongs, as Technological Report No. 8. Previous issues in both series are tabulated on the inside back cover.

With the current shortage of paper pulp showing every evidence of continuing, this revision of the earlier report becomes particularly timely, since bagasse offers one of the great untapped sources of a collected raw material from which pulp can

be manufactured. About 130 new references have been added to this second edition.

It has frequently been stated that ours is a paper civilization. The printed word holds its own as a means of distributing information despite the rapid development of electrical communications and the speed of modern travel. Concurrently, the advance of plastic and textile products based upon cellulose has rapidly increased the demand for particular types.

Estimates indicate that many, if not most, pulp-wood producing areas are being cut faster than the replacement by growth. Hence, additional sources of cellulose will undoubtedly be required in the future.

The present review of literature on the utilization of sugar-cane bagasse is intended to call attention to previous work on this subject, to bring this material together in convenient form, and to stimulate further experiment upon the numerous promising possibilities for diverse applications of bagasse with which this literature abounds.

ROBERT C. HOCKETT,
Scientific Director, Sugar Research Foundation, Inc.

PULP, PAPER, AND BOARD

1. AHMAD, N., and KARNIK, M. G. Technical survey of cellulose-bearing materials of India. *J. Sci. Ind. Research* (India) 2, 275–90 (1944)—*B. C. P. A.* 1944B, II, 352; *B. I. P. C.* 15, 252.

Yields, whiteness values, and ash and alpha-cellulose contents were determined for eleven varieties of plants which were pulped by the soda, sulfate, and sulfite processes. Bagasse cannot be pulped completely with alkali only; improved quality, but lower yield, is obtained after a predigestion with 3% nitric acid at 90° for 1.5 hours.

2. Aljian, Atchison, and Lathrop team with Hawaiian sugar industry to study utilization of bagasse. *Paper Trade J.* 133, no. 10, 172–4 (1951); *Chem. Eng. News* 29, 3720 (1951); *Pulp Paper Mag. Canada* 52, no. 10, 102 (1951); *Tappi* 34, no. 10, 74A (1951); *Chemurgic Digest* 10, no. 10, 14 (1951); *Fibre Containers* 36, no. 10, 64 (1951); *Paper Mill News* 74, no. 39, 26 (1915)—*B. I. P. C.* 22, 93; *Sugar J.* 14, no. 7, 32–4, 36 (Dec. 1951).

In a study of the possible utilization of bagasse for pulp and paper under way in Hawaii, the following problems must be considered: the development of an efficient method for the separation of the pith from the fiber and suitable uses for the pith fraction, the determination of the suitability of the fiber for use in the pulp and paper industry, and an investigation of the possibilities of manufacturing chemicals from molasses and bagasse.

3. ALVAREZ, ALEJANDRO S., and MANOV, ISAAC. The fiber content of different varieties of sugar cane. *Rev. ind. agr. Tucumán* 19, 315–19 (1929).—*C. A.* 24, 1536.

The fiber is calculated from the following equation: kilograms of fiber per 100 canes = kilograms of bagasse per 100 canes × (kilograms of fiber per 100 bagasse residues/100). Tables are given showing the weight of the sample, Brix, sucrose, glucose, purity, coefficient of glucose, obtainable sugar, and cane fiber. The quantity of fiber appears to be periodic during the year and is about 10.5%.

4. AMERICAN FIBER CO. Use of cane fiber for papermaking. New York, 1873.

5. ANNANDALE, ALEX. Papermaking industry in South Africa. *Pulp Paper Mag. Canada* 12, 459–60 (1914); *Paper-Maker* 48, 515, 517 (1914).

It is well known that bagasse or megass has been experimented with in various places, and not, so far as we know, with great success. In the writer's opinion the trouble is—that in sugar crushing countries, other than Natal, the crushing season is over in six weeks or so, while in Natal the crushing goes on for about nine months. From the writer's experience in handling megass, it is necessary, if a good white pulp is to be obtained, to get the material fresh from the crushing mill; otherwise, it will not come to a direct color, with any reasonable percentage of bleach. This megass, when handled fresh from the crushers, is more easily boiled than esparto and certainly no more difficult to bleach.

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6. Argentine paper mill. *World's Paper Trade Rev.* 121, 363–4, 366 (1944).—*B. I. P. C.* 14, 324.

Reference is made to a new bagasse pulp and paper mill which started production in January, 1943 in the Ebro mill, at Villa Ocampo, Province Santa Fé, Argentina; it is affiliated with, and adjacent to the Arno cane sugar factory. The mill is making at present a Yankee-glazed kraft wrapping paper. The procedure employed was developed by a Catalonian engineer, Pedro Mestres, who was also responsible for the installations. The mill works 24 hours daily in three shifts of 40 workers each; apart from the chief paper and the machine foreman, all labor was locally recruited, without industrial experience, and trained at the mill. This fact speaks well for the simplicity of the Mestres process. No details are given; the procedure calls for caustic soda as a basis, but is claimed to depart otherwise radically from usual mill practice. All the cellulose present in sugar cane is utilized and, for certain grades, also part of the hemicellulose; a 63% yield of pulp is claimed when fresh bagasse is employed. However, it has been proved in practice that the loss in yield on storage is negligible. The Ebro mill uses at present bagasse of the 1941 crop and obtains yields of 52%, calculated on the dry weight of the material.

7. Aronovsky, S. I. Bagasse. Pulp and Paper Manufacture 2, Chapter 1, Part 3, 79–81 (1951).

Bagasse, freed of leaves and other trash, consists of three types of fibrous tissues: pith, bundles, and rind; the quantities of these depend to some extent on variety, soil, cultural conditions, and weather. A representative bagasse contains about 25% pith, 20% bundles, and 55% rind fibers. Analyses of four samples of Louisiana bagasse from different crop years gave: ash 1.8 to 6.3%, solubility in alcohol-benzene 1.7 to 6%, solubility in hot water 4 to 9.1%, solubility in 1% sodium hydroxide 32.9 to 36.1%, lignin 18.9 to 26.6%, pentosans 28.4 to 30%, Cross and Bevan cellulose 55 to 60.2%, and alpha-cellulose 40 to 43.1%. The outstanding use of bagasse at present is as a raw material for a wide variety of insulating and hardboard products for the building industries. The bagasse is softened by a short cook in water or a dilute chemical and reduced to the proper size of fiber bundle by disk refiner, Hydrapulper, or other fiberizing equipment. Mention is made of the existing plants which make pulp and paper from bagasse. It is generally agreed that the pith should be removed from bagasse for the production of fine papers. Depithed bagasse can be made into good chemical pulp by the soda, kraft, neutral sulfite, Pomilio (soda-chlorine), and nitric acid processes. These pulps can be used for book, writing, magazine, and other papers requiring good formation, opacity, and printability. Satisfactory chemical pulps suitable for rayon and cellulose nitrate have also been prepared. Until a good, economical method for removing the pith from bagasse can be found, however, no large commercial production of fine chemical bagasse pulps can be expected.

8. Aronovsky, S. I., and Lynch, D. F. J. Pulping bagasse with alcoholic nitric acid; pulp yields and characteristics. *Ind. Eng. Chem.* 30, 790–5 (1938).—*B. I. P. C.* 8, 458; *C. A.* 32, 6456.

The following analysis is reported for a Louisiana bagasse (oven-dry material): moisture, 8.88%; alcohol-benzene (1:2) solubility, 1.69%; solubility in 7.14% sodium hydroxide, 40.95%; lignin (sulfuric acid method), 26.55%; lignin (hydrochloric acid method), 21.79%; pentosans, 29.09%; Cross and Bevan cellulose, 60.20%; alpha-cellulose, 43.12%; total chlorine used for Cross and Bevan determination, 31.9%; chlorine forming hydrochloric acid, 16.9%; chlorine combined with bagasse (by difference), 15%; total nitrogen, 0.175%; protein (nitrogen times 6.25), 1.09%; ash, 1.79%. The following conclusions are drawn from the pulping experiments with nitric acid. The bagasse was boiled with alcoholic and aqueous solutions of nitric acid and then with dilute solutions of sodium hydroxide. The alcoholic nitric acid treatment resulted in higher yields of pulp with considerably less attack on the alpha-cellulose and pentosans than was obtained with the aqueous acid. This is probably due to the inhibiting action of the alcohol on the hydrolytic activity of the nitric acid in degrading the carbohydrate constituents of the bagasse. An increase in the concentration of nitric acid, with all the other pulping variables held constant, resulted in lower yields of pulp with higher alpha-cellulose and lower lignin and pentosan contents. Mixtures of alcoholic and aqueous nitric acid solutions yielded results intermediate between those obtained with alcoholic or aqueous solutions alone. The pulp yields decreased with increased time of treatment with the acid liquors. The yield of pulp increased somewhat with the increasing ratio of total acid liquor to

bagasse, the other conditions remaining constant. Increasing the concentration of the alkali and the time of treatment with the alkali resulted in decreasing yields of pulp. The alcoholic nitric acid can be reused many times without affecting the yield and properties of the pulp. A 3% alcoholic or a 2% aqueous nitric acid solution appeared to be the best pulping agent; a temperature of 99–100° C. (i.e., water bath temperature) gave the best yield of pulp. A liquor-bagasse ratio of 15 to 1 was used in the experiments. The optimum concentration of sodium hydroxide apparently lies between 1.5 and 2.0% solution, equivalent to 22.5–30% on the basis of the untreated bagasse; one hour appeared to be the optimum period of treatment, longer treatment decreasing the pulp yield. It was calculated that 19.8–23.6% of the nitric acid was consumed in cooking, equivalent to 8.5–10.2% (as nitric acid) on the weight of the oven-dry weight of the bagasse. Experiments are reported in which six cooks were made with the same alcoholic nitric acid; the yields were fairly constant at 50%.

9. Aronovsky, S. I., and Nelson, G. H. Mechano-chemical process—rate of delignification. *Tappi* 34, 216–22 (1951); *B. I. P. C.* 21, 730.

Because of its less dense structure, plant material of the grass family, such as cereal grain straws, bagasse, or corn stalks, can be pulped practically in a relatively short cooking period without pre-impregnation. However, pre-impregnation shortens the cooking period still further and results in a more uniformly pulped product. The process was studied with straw but apparently can be adapted to other agricultural residues. Pulping-rate studies were made on wheat straw and with soda, kraft, and neutral sulfite pulping chemicals at 73°, 83°, and 93° C., in a small open vessel fitted with a high-speed stirrer. The most rapid pulping rate occurred in the first five minutes. Delignification continued after this period but at a greatly retarded rate. About 55% of the lignin, 30% of the pentosans, and 85% of the ash, based on the amounts of these constituents present in the original straw, were removed in the first five minutes; at the end of one hour, the amounts removed were 70, 35, and 90%, respectively. At the same concentration, caustic soda and the kraft chemicals gave practically the same degree of delignification of straw; sodium sulfite was too mild a cooking agent to produce satisfactory pulp at the low temperatures used. Both the higher cooking temperatures and the higher concentrations of cooking chemical increased the rate of pulping; the change in concentration of chemical had the greater effect. Mechano-chemical pulping of commercial straw in a 3-foot Hydrapulper gave results which were in good agreement with those obtained with the small laboratory vessel. It is believed that the speed and efficiency of delignification in mechano-chemical pulping are due largely to the increase, by mechanical action, in the diffusion velocities of the active chemicals and reaction products into and out of the fibrous plant material.

A news item in *Tappi* 34, no. 4, 74A (1951) states that it is possible to separate the pith and the fiber of bagasse and utilize both at a profit of about one dollar per ton of cane ground. The bagasse would be treated in a machine such as a Hydrapulper, the pith and fiber separated by screening, the fiber sold to papermakers for blending, and the pith used to absorb blackstrap molasses for sale as cattle feed.

10. Aronovsky, S. I., Reid, J. David, Dryden, E. C., Whittemore, E. R., and Lynch, D. F. J. Pulping with nitric acid. A review. *Paper Ind.* 21, 41–8, 151–5, 335–43 (1939).

This is a very complete review of the nitric acid process, with 170 references. The following review is given of the application of the process to bagasse. "In 1932, Lynch and Goss (No. 219) compared the pulping of bagasse by the soda, sulphate, neutral sulphite, and nitric acid processes. They showed that the nitric acid process gave good pulp in yields averaging about 4% higher than those obtained by the sodium sulphite process. The bagasse was steeped in 5 parts of 5% nitric acid for 3 hours. The excess acid (about 70% of the total) was drained off and the residue was heated for 1 hour in a water bath at 80° C., and then washed thoroughly and boiled for 30 to 45 minutes in a 2% alkali solution. The resulting material was a soft easy-bleaching pulp, with the bleached pulp containing 86 to 93% alpha-cellulose, 0.4% ash, 9 to 11% pentosans and having a solubility of 16 to 31% in boiling 7.14% alkali. (The high alkali solubility may be due, in part, to the solution of the finer cellulose fibers in the alkali.) A product containing 93 to 97% alpha-cellulose and 5 to 11% alkali-soluble material may be obtained by treating the bleached pulp with a 9% alkali solution at 100° C. The used alkali is then diluted to the 2% solution required for pulping. The high

alpha-cellulose pulp compared favorably with purified bagasse pulp made by other processes. The recovered acid was reused 7 times and substantially the same yields of pulp were obtained as with fresh nitric acid. A brief discussion of the economics of the nitric acid process indicated its favorable commercial possibilities. In 1943, Lynch (No. 217), reporting results obtained on bagasse in Hawaii, stated that the soda-soluble content could be reduced further. A change to the use of hot dilute nitric acid solution necessitated the use of "18–8" stainless steel for the reaction vessel.

In 1933, Malowan (No. 510) stated that nitric acid bagasse pulp measured up to the standards required for the production of nitrocelluloses and that this pulp was better than soda bagasse pulp. He stated that the future of nitric acid bagasse pulp was therefore assured. Arroyo (No. 16) found that the Lynch and Goss method gave satisfactory pulp from Puerto Rican bagasse.

Payne (No. 303) reported that the optimum acid concentration for pulping bagasse was 2%; digestion longer than one hour did not improve the pulp. A 1.25% nitric acid solution did not give a satisfactory pulp. While he found that the consumption of nitric acid by the method of Lynch and Goss varied from 13 to 20%, the use of a hot 2% solution consumed 3.9% in one hour and 6.5% in two hours on the basis of the pulp. The treatment of the pulp with a hot 5% solution of caustic soda increased the alpha-cellulose and decreased the soda-solubles.

Although Schaarschmidt and Nowak (*Cellulosechem.* 13, 143 (1932)) had found that pretreatment of the raw material (wood) with cold 8% caustic did not decrease the nitric acid consumption, Foster (No. 90) in 1935 showed that pretreating bagasse with 0.5% sodium hydroxide for one to three hours at 71° C. gave a better quality nitric acid pulp. After the pretreatment, the pulp was steeped for two to four hours in 2% nitric acid at 71° C. It was then treated with 5% sodium hydroxide at 49° C. for three to six hours. The resulting fiber was bleached with 1 to 3% hypochlorite, the bleach consumption being one-fifth of that required for the usual commercial pulps."

11. Aronovsky, S. I., Rhodes, Alan, and Lathrop, E. C. Agricultural residue pulps—comparison with typical wood pulps. *Tech. Assoc. Papers* 30, 83–9 (June, 1947); *Paper Trade J.* 124, no. 13, 49–55 (1947); *Paper Mill News* 70, no. 27, 12, 14, 16, 18; no. 28, 16–18 (1947); *Paper Ind.* 29, no. 2, 277–9 (1947).—*B. I. P. C.* 17, 445; *C. A.* 41, 2892; *B. A.* 1947B, II, 188; *Tech. Bull.* 24, 38.

Data on agricultural residue pulps, obtained with the same equipment and techniques used for wood pulps, show that the farm residue pulps compare favorably with the wood pulps in all the strength characteristics except tear resistance. The residue fibers are shorter than coniferous wood fibers but they are considerably smaller in diameter than the wood fibers. The farm residue pulps contain larger amounts of pentosans and, hence, they hydrate more readily. The fibers studied included soda pulps from bagasse, flax shives, hemp hurds, rice straw, and wheat straw. The equipment used included standard laboratory beaters with sharp and dulled tackle, a Morden laboratory beater, and a fiber fractionator. The data are given in the form of curves. Bagasse cooked with 15% sodium hydroxide at 170° C. for 2 hours gave 57.6% crude pulp, 49.2% screened pulp, 0.4% screenings, and 8% fines. It contained 24.8% pentosans, 2.8% lignin, and 0.9% ash. The pulps would be useful for specialty products.

12. Aronovsky, S. I., Younger, J. O., and Nelson, G. H. Agricultural residue pulps for corrugating—effect of weathering and of various cooking conditions. *Tech. Assoc. Papers* 28, 637 (1945); *Paper Trade J.* 120, no. 8, 124, 126, 128, 130, 132 (1945); *Paper Mill News* 68, no. 8, 102, 104, 106, 108, 110 (1945).—*B. I. P. C.* 15, 259; *C. A.* 39, 1985.

The materials included in this study were sound and weathered wheat and rice straws, soybean stalks, hemp hurds, flax shives, barley straw, sugarcane bagasse, and sedge or "wool" grass. The analysis of the sound bagasse was as follows: moisture, 10.6% ash, 6.3%; alcohol-benzene solubility, 4.0%; hot-water solubility, 9.1%; 1% sodium hydroxide solubility, 36.1%; lignin, 19.8%; pentosans, 28.4%; Cross and Bevan cellulose, 55%; alpha-cellulose, 40.6%. The bagasse was cooked under three conditions at 140° C., using 6, 4, and 8% calcium oxide, and 1.5, 2.5, and 2.5% sodium hydroxide, respectively, for a period of five hours. The physical characteristics of the resulting pulps are given. The sugar cane bagasse gave somewhat higher yields of washed pulp than were obtained from wheat straw under similar pulping conditions. However, the bagasse pulps

were weaker, and resembled the rice and barley straw pulps in strength characteristics. The indicated variation in the amount of chemicals used seemed to have no particular effect on the yields and properties of the pulps. The cooked bagasse seemed to be raw when compared with the straw pulps and required more time for disintegration in the beater.

13. ARROYO, RAFAEL. Alpha-cellulose from sugar-cane bagasse and foliage. *Puerto Rico Sugar Manual*, 26–7; *Intern. Sugar J.* 42, 359–60 (1940).—*C. A.* 35, 4988.

After being comminuted and air dried, the bagasse and foliage were immersed overnight in a 50% dilution of propionic acid containing about 2.5% of acetic acid and then heated for 6 hours, washed, and dried. After being treated successively with alkali and hypochlorite, the material was washed in a centrifuge and dried. Bagasse pulp thus obtained is said to contain 92–95% of alpha-cellulose (0.3% ash) and 10–12% of alkali-soluble matter.

14. ARROYO, RAFAEL. By-products of the sugar industry. *Facts About Sugar* 35, 64–5 (1940).

15. ARROYO, RAFAEL. Chemical investigations of the Puerto Rico College Station. *Puerto Rico Coll. Sta. Rept.* 1936, 26–33.—*C. A.* 33, 9027.

Notes are given on studies of the preparation of high-grade alpha-cellulose from sugar-cane foliage and bagasse by a method particularly adaptable to Puerto Rican conditions.

16. ARROYO, RAFAEL. Chemical work of the Puerto Rico College Station. (Sugar-cane bagasse.) *Puerto Rico Coll. Sta. Rept.* 1934, 46–7, 151–7.—*T. S.* 104, 63; *C. A.* 30, 6594.

Data are reported for the production of alpha-cellulose from cane bagasse and foliage in which the organic aliphatic acids (especially those inexpensively prepared from blackstrap molasses) can be substituted for nitric acid. (This is probably butyric acid.)

17. AUSMAN, L. H. Bagasse paper. *Paper Box and Bag Maker* 98, 113–4 (1944); *World's Paper Trade Rev.* 122, 1154 (1944).—*B. I. P. C.* 15, 197.

The possibility of utilizing the bagasse pulp from sugar mills in the United States, Cuba, and Puerto Rico is pointed out, not to replace but to extend and conserve present woodpulp supplies. Bagasse pulp is best for paper when mixed with wood pulp, waste paper, straw pulp, or other fibrous materials. The mixed pulp lends itself to the production of kraft wrapping paper, bags, nine-point cardboard, corrugated board, and other forms of board used in the manufacture of containers. It is further advocated that the pulp, being less bulky than bagasse, should be prepared in the sugar-mill districts and shipped to paper mills for conversion. Raw-sugar mills operate only from three to four months a year, so that the idle manpower could be utilized in the pulp mills for the remainder of the year.

18. BABCOCK, LEON W. Method for producing low-density pulp. U. S. patent 1,777,710 (Oct. 7, 1930).

Sugar-cane pulp or fiber is subjected to a boiling treatment in water in any suitable apparatus, the amount of water being just sufficient to saturate and immerse the pulp. The pulp, after being boiled for 15 to 60 minutes, is dried and will be found to be greatly reduced in density; percentage changes of 30 to 44% are reported. The result of the boiling treatment in lowering the density of the sugarcane pulp is dependent to some extent upon the relative fineness of the pulp treated, the density of the lot containing relatively coarse pulp being lowered to a greater degree than that of the other lots; a screen test on the three pulps used is given. The lowered density of the pulp enables the preparation of a relatively very low density dynamite, having a desired relatively high cartridge count per unit weight.

19. BACHE-WIIG, CARL. Method of preparing pulp. U. S. patent 1,455,471 (May 15, 1923).

Bagasse, straw, corn stalks, or the like, cut into suitable lengths, is soaked in a solution containing from 0.5 to 3% sodium chloride for 12 to 72 hours at a temperature of 70 to 110° C. The treated material is then pulped with a bisulfite liquor or with sodium chloride solution, depending on the type of paper desired.

20. Bacteria in pulp. *World's Paper Trade Rev.* 104, 1101 (1935).

When bagasse is piled up during the sugar-grinding season faster than board can be manufactured from it, it is subject to attack by bacteria and fungus. By simply forming it into bales, the bacteria feeding on the sugar remaining in the pulp caused fermentation which raised the temperature to 140° F., at which temperature the bacteria are killed.

21. Bagasse. The Dictionary of Paper, 2nd ed., p. 22 (1951).

Bagasse is extensively used for wallboard and insulation. The pulp is prepared by mechanical disintegration in the presence of water, either with or without a mild chemical treatment, and is a coarse bulky pulp of low strength, particularly suited for the manufacture of boards and insulation. Attempts have been made to manufacture bleached pulps suitable for fine papers from bagasse.

22. Bagasse. *Paper Makers' Mo. J.* 45, 101 (1907).

23. Bagasse. *Paper Trade J.* 39, no. 3, 20; no. 5, 14; no. 14, 22; no. 16, 22; 41, no. 18, 8; no. 22, 14; no. 26, 14; 42, no. 9, 10; no. 10, 20; no. 15, 54, 58; no. 17, 38, 42; 43, no. 2, 42, 46 (1904–1906).

24. Bagasse and bamboo for papermaking. *Paper* 5, no. 12, 21 (1911).

This is a news item on the possible uses of bagasse in South American countries. The Consul at Trinidad reports on experiments in which bagasse and bamboo are mixed to give a satisfactory paper. "The producer has used no chemicals in making the paper." P. Carmody, Director of Agriculture, Trinidad, confirms the report and states that other materials may be blended with the bagasse, such as banana leaves and stems, maize residues, agave, hibiscus, bois de canon, sunflower, native grasses and other products. The best results have been obtained from a blend of bagasse, bamboo and Para grass.

25. Bagasse and its uses. *News Letter*, Louisiana Dept. Commerce and Industry Committee; *Chemurgic Digest* 5, no. 10, 182–3 (1946).

Announcement is made of research at Louisiana State University on the utilization of bagasse as a papermaking material. The nitric acid process is to be employed. The pith is separated from the fiber and the former is used in the manufacture of dynamite. No details are given.

26. Bagasse as a papermaking material. *Paper Making* 28, 359 (1909).

27. Bagasse as a raw material for paper. *Papier-Ztg.* 38, 209 (1913).

28. Bagasse as raw material for paper making. *Papier-Fabr.* 9, 478–80 (1911); 14, 31 (1916).

A brief discussion is given of the possibility of manufacturing paper from bagasse in the tropics. No technical details are included. The product is suitable for wrapping purposes.

29. Bagasse as a raw material for paper pulp. *Science Industry* 1, 334 (1919).

30. Bagasse as paper material. *Papier-Fabr.* 7, 1185–7 (1909).

31. Bagasse as papermaking material. *Paper Makers' Mo. J.* 42, 47–8 (1904).

32. Bagasse as stock (box board). *Paper Mill* 29, no. 8, 7; no. 15, 14, 32 (1906).

33. Bagasse for paper. *Paper Mill* 32, no. 5, 12 (1909).

34. Bagasse: Its adaptability in the production of the best book and writing paper. *World's Paper Trade Rev.*, July 8, Aug. 26, Sept 16, 1904.

35. Bagasse: Its utilization and treatment as a papermaking raw material. *World's Paper Trade Rev.*, Aug. 25, Sept. 15, Oct. 13, 20, Nov. 10, 17, 1905; Feb. 9, Mar. 30, June 22, 1906.

36. Bagasse makes a good white paper. *Paper Makers' Mo. J.* 47, 11–2 (1909); *Paper Trade J.* 47, no. 18, 52 (1908).

37. Bagasse or megass in papermaking. *Paper Trade J.* 49, no. 22, 30, 32 (1909).

38. Bagasse used in Holyoke. *Paper Trade J.* 130, no. 6, 11 (1950); *Chemurgic Digest* 9, no. 3, 8–10 (1950).—*B. I. P. C.* 20, 468.

The properties of the bagasse paper made by the Timlowski technique are evaluated. The pulp, which in many respects resembles cornstalk pulp, is short fibered, reasonably slow, and closes up well. The Mullen test is good, tearing

strength low, and opacity poor. The finished sheet in newsprint weight had the appearance of a greaseproof paper; it was stiffer and harder than normal printing papers and slightly brittle when dry. It had a sandy, not-too-smooth finish which, in turn, affected the printing quality. The yield was reported to be 55 to 60% after bleaching; the chemicals used and their consumption were not mentioned. From the results obtained to date it would appear that the logical grades for this type of pulp are 9-point corrugating medium, lower grades of writing and tablet papers, various printing papers, and greaseproof and glassine. The material must be studied further and evaluated, especially in terms of blends with other long fibers. Cf. No. 294.

39. Baldwin, Clara. Sugar cane board: wood pulp and bagasse used in Peru mill. *Am. Boxmaker* 37, no. 2, 11 (1948).—*B. I. P. C.* 18, 498.

Container boards and paper bags are being produced from a mixture of sugar cane bagasse and wood pulp at the Lima, Peru, plant of the Paramonga Box and Bag Plant. The wood pulp adds strength to the bagasse pulp and, to some extent, offsets the natural harshness of the latter. The paper, dark brown in color, is not being bleached, although experiments on this process are underway. The corrugating medium is made from bagasse combined with waste paper. The box plant operates two corrugating machines equipped to produce either A or B type flutes. The first automatic feeder for the box machinery, a partition slotter, was received in December, 1947; a combination printer-creaser is on order. In spite of the very humid climate, there has been little trouble because of the loosening of adhesive bindings. The absorbent surface of the bagasse paper helps solve the moisture problems in printing.

40. Barrett, M. C. Vazcane process. *Facts About Sugar* 25, 679–82 (1930).

41. Baskin, Charles M., and McLeod, Norman W. Method of producing fibrous building compositions. U. S. patent 2,473,190 (June 14, 1949).—*B. I. P. C.* 19, 819.

Mechanically disintegrated bagasse is mixed with about 0.5 part of a flux oil and stored for one to two weeks; the mixture is digested with 10% lime for about two hours at about 100 pounds per square inch. The digested product is then mixed with a clay-water-asphalt slurry (in which up to 75% of heavy metal salts or organic acids, such as aluminum or copper naphthenate, may be incorporated) and the product is formed into a web on the blanket of a wet machine. The process can be applied to the preparation of a laminated product.

42. Baunard, Walter. Making money from bagasse. *Sugar* 21, 122–3 (1919).—*C. A.* 13, 1028.

The price of paper is high, whereas fuel will probably be cheaper, because of new oil discoveries and of new processes for the utilization of lignite and peat. Under these circumstances, it would pay better to use bagasse for papermaking than for fuel.

43. Becher, Hubert L. Pulpboard. British patent 354,001 (July 13, 1929).—*T. S.* 97, 259.

Material such as raw wood fiber, chemically digested wood fiber, straw, bagasse, etc., is freed from the bulk of associated water, without any substantial application of pressure, and is then subjected to heat and pressure to remove water colloidally associated with the fibers, and may be combined with a binder for making pulpboard by hot pressing.

44. Becker, F. G. L. Fine paper production from bagasse. *Paper Trade J.* 131, no. 11, 14, 18–20 (1950).—*B. I. P. C.* 21, 76.

The island of Oriental Negros in the Philippine Republic has the only pulp and paper mill regularly producing fine printing, bond, and typewriting papers on a commercial scale from sugar cane bagasse as the raw material. The mill is continuous throughout and employs the Celdecor-Pomilio soda-chlorine process. The procedure is outlined and various parts of the mill are described.

45. Becker, F. G. L. Twenty-five years' pulping developments of agricultural residues. *Paper Trade J.* 132, no. 12, 16, 18, 21–22, 24, 26 (1951).—*B. I. P. C.* 21, 583.

The history of papermaking from straw, grasses, and bagasse is traced and the current production of paper from these raw materials is summarized. The various mills and their pulping operations are described, with particular reference to

the chlorine process and the part played by the Cellulose Development Corporation in England.

46. Bhargava, M. P., Kasbekar, G. S., and Bhargava, R. P. Utilization of bagasse for wrapping and bag paper manufacture. Cellulose and Paper (New Series), Indian Forest *Bull.* No. 148. 1949. 20 p. *B. I. P. C.* 21, 380; *C. A.* 45, 6839.

The results of laboratory and pilot-plant tests on bagasse as a source of paper are given. The following analysis of bagasse is given: cold water solubility, 6.8%; hot water solubility, 8.85%; 1% sodium hydroxide solubility, 16.50%; 10% potassium hydroxide solubility, 44.17%; alcohol-benzene solubility, 0.46%; ether solubility, 0.38%; lignin, 16.9%; cellulose (Cross and Bevan), 57.3%; pentosans, 22.8%; ash, 2.2%. The average fiber length was 1.47 mm. (max., 4.6 mm.; min., 0.533 mm.). Details are given of a number of sulfate cooks of bagasse; the strength properties and the yields are high enough for the economic use of these pulps for kraft wrapping papers. Admixture of the bagasse fibers with Sunn hemp, pinewood, or bambo pulps, with or without a binding agent, such as tamarind seed pectin, yields paper suitable for multi-ply bag papers.

47. Bhargava, M. P., and Nayer, A. N. Manufacture of insulation and pressed boards, etc., from bagasse. *Intern. Sugar J.* 45, 45–7 (1943).—*B. C. P. A.* 1943, II, 181; *B. I. P. C.* 14, 4.

Details are given for the preparation of the stock, using the Asplund defibrator, for the moisture- and fireproofing, and preservation of boards, and for the manufacture of wrapping boards and strawboards from bagasse. Estimates of the cost of production and profits of insulation board (0.5 inch) and pressed board (0.25 inch) are presented. Santobrite with rosin is the preservative recommended in the manufacture of the boards.

48. Bradley, Linn, and McKeefe, E. P. Production of pulp. U. S. patent 1,887,899 (Nov. 15, 1932).—*T. S.* 97, 319.

Although applied primarily to wood, it is stated that the following process may be used for bagasse, reeds, bamboo, grasses, etc. The improvement in the sulfite process which is claimed consists in the removal of the air or other gases or vapors from the digester after it has been filled with the raw material and before adding the cooking liquor. This exhaustion is facilitated by the heat which may come from the residual heat left in the digester from the previous cook. By subjecting the raw material to a vacuum, it is freed from air, etc., to such a degree that it is much more readily and thoroughly penetrable by the cooking liquor or the gaseous sulfur dioxide. An advantageous method of procedure is to introduce gaseous sulfur dioxide into the digester after it has been evacuated and before introducing the cooking liquor.

49. Brito, Eduardo M. Vazcane fiberboard from sugar cane. *Mem. conf. anual. Asoc. tecnicos azucar., Cuba* 19, 419–422 (1945); *Sugar* 41, no. 11, 28–30 (1946).—*C. A.* 40, 5941.

Sugar cane is rasped in a pilot plant on a rapidly revolving cylinder of carborundum with a specially prepared face. The resulting semi-liquid mass of fiber and juice is counter-currently diffused against water at 90° C., whereby 99% of the original sucrose is extracted; this juice is sent to the neighboring sugar factory to be mixed with the clarifier muds going to the filters. The sugar-free pulp is converted to fiberboard. In addition to practically complete extraction of the sucrose, the whole of the fiber in the cane is utilized.

50. Brown, N. G. Simmons' shredded cane process. *Louisiana Planter* 49, 301 (1912).—*C. A.* 7, 287.

The cane is cut and shredded, then passed into rotary driers which admit direct heat, giving a high temperature in the first stages of drying. No inversion of sucrose occurs. The cane so dried can be baled to be worked later.

51. Brubacher, William G. Apparatus for wallboard. U. S. patent 2,428,512 (Oct. 7, 1947).—*C. A.* 41, 7754.

A vat fitted with plungers is used for the manufacture of fiber boards from wood pulp, bagasse, and the like.

52. Buswell, A. M., and Boruff, C. S. Production of pulp by a fermentation process. British patent 360,922 (Aug. 13, 1930); French patent 700,200 (Aug. 8, 1930); cf. *Cellulose* 1, 108–10, 162–5 (May, July, 1930).—*T. S.* 94, 3; 97, 233; *C. A.* 25, 3832.

Cellulosic material, such as bagasse, is made suitable for the production of paper and the recovery of methane by boiling or steeping the material and subjecting it to the action of anaerobic bacteria in the absence of oxygen, collecting the gas produced, and washing the solid residue.

53. Cane sugar residues. *Chemurgic Digest* 8, no. 2, 10–11 (1949).—*B. I. P. C.* 19, 459.

The article contains a discussion of the uses of bagasse, including the manufacture of paper, board, rayon, and plastics.

54. Carmody, P. Paper from megass. *Bull. Imp. Inst.* 8, 151–2 (1910).—*J. Soc. Chem. Ind.* 29, 1053.

Experiments by Bert de Lamarre in Trinidad have shown that megass (refuse from sugar cane factories) is more suitable for papermaking when it is mixed with other fibrous materials, such as banana leaves and stems, maize residues, agave, hibiscus, bamboo, bois de canon (*Cecropia peltata*), sunflower, native grasses, etc. The best results have been obtained with a mixture of megass, bamboo and Para grass. It is estimated that there are 50,000 tons of megass available per annum in Trinidad, which would yield 40,000 tons of pulp of a value of at least £200,000, or 30,000 tons of a pulp of better quality worth £360,000. If the megass were mixed with bamboo and Para grass, the pulp would be worth £450,000.

55. Celotex installs another big board machine. *Paper Trade J.* 89, no. 18, 104, 106 (1929).

A news item regarding the Celotex Co., Marrero, La., in which mention is made of the various products manufactured from bagasse. No technical details are given.

56. Clerc, J. F. De Vains process for paper pulp from waste fibrous materials. *Chem. Met. Eng.* 30, 262–5 (1924); *Paper Trade J.* 78, no. 8, 43–7 (1924).—*T. S.* 79, 27.

A general description is given of the De Vains process, which consists in the successive treatment of the raw material with dilute caustic soda, chlorine hydrate, and bleach. The process has been applied to straw, esparto, and rice fibers and successful tests have been carried out with bamboo. It is stated also that the De Vains process can profitably transform bagasse into pulp; no further details are given.

57. Companhia industrial de cellulose. Treatment of bagasse for conversion into cellulose or pulp for paper or boards. French patent 394,143 (Aug. 8, 1908).—*J. Soc. Chem. Ind.* 28, 257; *C. A.* 4, 109.

Bagasse is boiled in pure water under a pressure of 4–6 atmospheres for 3–6 hours, 5–10% of petroleum (on the weight of the bagasse) being added during the cooking operation. The resulting pulp is suitable for the manufacture of board.

58. Connon, G. W. Manufacture of paper pulp from bagasse. *Proc. Hawaiian Sugar Planters' Assoc., 48th Annual Meeting,* 1928, 353–65 (1929).—*C. A.* 23, 5315.

The manufacture of paper pulp from bagasse by the Roza process at Tuinucu, Cuba, is described, and the economics of the process are discussed.

59. Consiglio, Giulio. Use of the chlorine gas process in the paper industry: its present applications and future possibilities. *Papier* 28, 1291–300 (1925).—*T. S.* 83, 43; *C. A.* 20, 1518.

A general discussion is given of the Consiglio chlorine process, which uses chlorine gas after a preliminary treatment with sodium hydroxide. Tests have shown the possibility of economically treating bagasse by the chlorine gas treatment. In three tests, using, respectively, 12, 23, and 7 kg. of alkali and 58, 20, and 28 kg. of chlorine per 100 kg. of bleached cellulose, the yields were 45, 44, and 45% of bleached pulp.

60. Cross, C. F., and Bevan, E. J. Textbook of papermaking. 5th ed. London, Spon, 1920.

"From the close botanical relationship of bamboo and sugarcane to (the stems of) the Gramineae of our own climate, their microscopic features are, as might be expected, similar to those of straw. The similarity is further shown by the chemical composition (Hugo Müller):

	Air-dried
Cellulose	50. 13
Fat and wax	0. 78
Aqueous extract	10. 56
Lignin and pectous substances	24. 84
Water	8. 56
Ash	5. 13."

61. Cross, W. E. By-products of the sugar industry. *Rev. ind. agr. Tucumán* 13, 81–128 (1922).—*C. A.* 17, 3426.

A general discussion of methods of utilizing bagasse.

62. Darling, Elton R. Pulping farm wastes. U. S. patent 1,828,243 (Oct. 20, 1931).

Comminuted bagasse, corn stalks, or other farm waste is digested with 1% sodium hydroxide containing 0.1% sodium sulfite for about two hours at 20 pounds pressure in a closed digester; the material is screened and the coarser particles are retreated with a 2% sodium hydroxide at 50 pounds pressure for about two hours.

63. Darling, E. R. Cellulose pulp from cornstalks, straw, etc. U. S. patent 1,845,487 (Feb. 16, 1932); British patent 314,061 (June 22, 1928).—*T. S.* 91, 184; *C. A.* 24, 1219; 26, 2318.

Bagasse and similar materials, of low lignin content and relatively high pentosan content, are shredded and cleaned and then digested in hot water at about 10 pounds pressure, the water is drawn off, heated, and spread into the top of the digester, passing out at the bottom and carrying with it the water-soluble substances. The material is then hydrolyzed (suitably with a dilute sulfuric acid solution), washed, and degraded with dilute alkali under heat and moderate pressure.

64. Darling, Elton R. Process of producing cellulosic pulp. U. S. Patent 1,845,488 (Feb. 16, 1932).—*C. A.* 26, 2318.

Agricultural residues are digested with a 1% sodium hydroxide solution; the strength of the alkali during the digestion is maintained by the gradual addition of a 40% sodium hydroxide solution.

65. Denis, Julien. Improvement in the preparation of paper-pulp and manufacture of paper. U. S. patent 113,502 (April 11, 1871).

"I dissolve in about two hundred gallons of hot water one hundred and seventy-five pounds of carbonate of soda or alkali, fifty-six pounds of sulphate of soda, forty pounds of sal ammonia. When the dissolution is perfect I throw in fifty gallons of chlorine at 2° of the acidimeter Baumé. I put one hundred and fifty pounds of quick-lime to dissolve in cold water, which is allowed to settle and draw clear, and put it in the bath. Care should be taken that the lye be about six inches from the top of the pan when the raw material is put in, as the steam which condenses in the pan often produces too much water. The liquid must cover the raw material by adding sufficient water. If the lye does not cover it the lid is shut down to keep in the steam. The mass is to be boiled for four, six, or sometimes eight hours, according as the material may be more or less difficult to reduce." This process is said to be applicable to bagasse, etc.

66. Dereser, R. Use of sodium xylenesulfonate as a hydrotropic compound in the chemical industry. *Angew. Chem.* 63, 327–8 (1951); *B. I. P. C.* 22, 49.

Reference is made to the work of McKee on the use of sodium xylenesulfonate as a pulping agent [see Nos. 221–224].

67. Dils, Logan A. Method of treating fibers for paper making and other uses. U. S. patent 1,846,093 (Feb. 23, 1932).

Crude pulp (from wood, flax straw, bagasse, and the like) (100 pounds) is treated with eight ounces of nickel sulfate and one ounce of zinc sulfate in 500 pounds of water in a digester at a pressure of 100 pounds (about 15 minutes);

after relieving the pressure, the mass is treated with hot water, two ounces kieselguhr, four ounces magnesium carbonate, and two ounces of calcium carbonate are added, and the material is subjected to the action of hydrogen until foaming ceases. The pulp can be bleached by the use of six to eight ounces of sodium perborate for each 500 pounds of water. This hydrogenated pulp has superior strength and is a clear white.

68. Dils, Logan A. Method of treating fibers for paper making and other uses. U. S. patent 1,868,569 (July 26, 1932).

Flax straw, bagasse, or the like is pulped with a solution containing 50% water, 39% sodium borate, 10% sodium hydroxide, and 1% trisodium phosphate for a period of time varying from 10 to 20 minutes at a temperature of 220 to 225° F.

69. Dils, Logan A. Process for treating woody materials to obtain fibers therefrom. U. S. patent 1,868,570 (July 26, 1932).

Bagasse and similar materials are pulped for 15 to 45 minutes at atmospheric pressure with a solution containing 45% water, 49% sodium hydroxide (76%), 1.25% sodium thiosulfate, 2.25% sodium borate, and 2.5% trisodium phosphate.

70. Dixon, John W. Manufacture of paper pulp. U. S. patent 45,321 (Dec. 6, 1864).

Wood is treated with caustic soda, using 40 gallons of a 16–20° Bé. solution for 100 pounds of wood at 212–300° F. for about 6 hours. Upon draining the cooking liquor, about 30 gallons of alkaline solution (12° Bé.) are obtained; this is diluted to 60 gallons and used to digest straw, bagasse, etc.

71. Doane, Foster P., Jr. Building a paper mill to use residual agricultural material. *Southern Pulp Paper Manuf.* 13, no. 11, 16, 20 (1950).—*B. I. P. C.* 21, 265.

The use of residual agricultural materials is not new; they were employed before wood pulp, and their use is bound to increase for two reasons: first, because of the increased use of paper and board, which requires additional amounts of raw materials which the forests cannot supply and, second, because of improved technical methods of harvesting, handling, and processing. A wide variety of fine and coarse papers, boards, and wallboards of good quality can be produced. In countries which do not have wood but which have straw, bagasse, or cottonstalks, a sound industry can be built up. Several mills which operate successfully are listed as proof. Straw pulp could be used as a substitute for sulfite in newsprint, but such a procedure is not practical. Newsprint mills are not located in straw-producing areas, so that the process would be too expensive. A 100% straw or bagasse newsprint sheet is not feasible, because such pulp cannot compete with wood pulp in price and does not give the required printing surface. However, it is inevitable that more mills will be designed and built to use residual agricultural materials in the near future, but in order to insure their success, a careful cost study must be made.

72. Dorner, Bela. Method of treating cellulosic material. U. S. patent 1,819,152 (Aug. 18, 1931); British patent 286,211 (Feb. 28, 1927); Canadian patent 284,755 (Nov. 13, 1928); French patent 644,599 (Oct. 28, 1927).—*C. A.* 23, 277, 979; 25, 5769.

The improvement claimed in this patent (which may be applied to straw, cornstalks, bagasse, etc.) consists in chopping or shredding the raw material, after which it is sieved dry to remove finely divided material which is unsuitable for pulp because it lacks the proper cellulose content or because of shortness of fibers. The material is then washed with sufficient disintegration (e. g., in a beater) so that water can penetrate into the cells and remove the dirt from inaccessible spots, such as the pockets formed by the leaves. The washed material is then subjected to a two-stage alkaline cook.

73. Dorner, Bela. Process for the manufacture of cellulose pulp from cornstalks, sugar cane, etc. Austrian patent 119,483 (May 15, 1930); British patent 312,634 (May 29, 1928).—*T. S.* 91, 184; 92, 269; *C. A.* 24, 959.

After a coarse preliminary purification, the raw materials are washed during crushing and cooked simultaneously or immediately afterwards with caustic alkali at low temperatures (60–100° C.) and with a liquor concentration under 1% without breaking up the individual fibers. A second cooking process follows

with more drastic action, under 1–2 atmospheres pressure and with a liquor concentration of 1–1.5%. The pentosans and other organic substances are removed from the remaining liquor by precipitation with sulfur dioxide or gases containing such, and mixed with liquors occurring during the process and used in the usual manner for cattle feed or similar purposes.

74. DREWSEN, VIGGO. Cornstalks and bagasse. The merits of these waste products as paper making materials. *Paper Trade J.* 48, no. 5, 131–7 (1909); *Paper Makers' Mo. J.* 47, 124–7 (1909).—*Auszüge* 1909, 72.

75. DREWSEN, VIGGO. Process of manufacturing products from cornstalks, sugar-cane, etc. U. S. patent 731,290 (June 16, 1903); British patent 15,297 (July 8, 1904).—*J. Soc. Chem. Ind.* 22, 876.

The raw material is cut into small pieces and cooked with a solution of about 5 pounds of caustic soda in 70 gallons of water for about 2 hours at about 60 pounds per square inch. After the pith is disintegrated, it is separated by washing and by passage through a scraping or raking machine. The partly digested fibers are then cooked a second time, using a solution of about 7 pounds of caustic to 11 gallons of water, which may require about 6 hours under a pressure of about 60 pounds per square inch. The cooked pith and the fibers may be mixed in any desired proportions.

76. DREWSEN, VIGGO. Manufacture of products and paper from cornstalks, sugar cane, sorghum, etc. U. S. patents 789,416, 789,417, 789,418 (May 9, 1905).—*J. Soc. Chem. Ind.* 24, 633.

Patent 789,416 covers the process of producing opaque, soft, non-filled paper from sugar cane, cornstalks, sorghum, and analogous pithy stalks by cooking in a closed vessel under steam pressure in a cooking liquor containing from 15 to 30% of caustic soda (calculated from the bone-dry weight of the stalk) for from 4 to 10 hours according to the strength of the liquor employed and under a steam pressure of from 60 to 100 pounds, until the pith cells have been converted into soft absorbent pulp instead of parchment-like, water- and grease-repellent pulp. The cooked pulp, without beating, is run upon the paper machine.

Patent 789,417 covers the process of making an opaque, soft, imitation coated paper, which is the same as the above except that the pulp is mixed with a filler before being run onto the machine.

Patent 789,418 covers the production of a translucent, non-brittle writing and imitation parchment paper which is similar to the first patent, except that the pulp is beaten until the pith cells are broken up and opened before the stock is run onto the paper machine.

77. DREWSEN, VIGGO. Manufacture of paper from maize stalks, sugar cane and similar pithy stems. U. S. patent 798,887 (Sept. 5, 1905); French patent 344,692 (July 9, 1904).—*J. Soc. Chem. Ind.* 23, 1233.

This is a process of producing soft, absorbent pith cells from sugar cane, cornstalks, and the like freed from their incrustaceous matter (in contradistinction to parchment-like, grease-repellent pith cells), which consists in cooking the stalks in a closed vessel under steam pressure in a cooking liquor containing from 15 to 30% of caustic soda (calculated from the bone-dry weight of the stalk), for from 4 to 10 hours according to the strength of liquor employed and under a steam pressure of from 60 to 100 pounds until the pith cells have been converted into soft, absorbent pulp instead of parchment-like, water- and grease-repellent pulp.

78. DREWSEN, VIGGO. Paper pulp from corn stalks, etc. U. S. patent 853,943 (May 14, 1907).—*C. A.* 1, 2191.

The bagasse, cornstalks, etc., are split and cut into pieces which are cooked with about 15% of sodium hydroxide (based on the dry weight of the raw material) for about 6 hours at a steam pressure of 60 pounds. After screening to remove unpulped material, the stock is introduced into a beater, the washers of which are covered with perforated metal sheets or wire mesh, provided with openings large enough to allow the pith cells to pass through but small enough to retain the fibrous material. The fibrous material is run directly onto the wet machine. The pith cells are allowed to settle to the proper consistency and then run onto the wet machine.

79. DREWSEN, VIGGO. Fiber-producing process and resulting fiber material. U. S. Patent 996,225 (June 27, 1911).

Bagasse and like materials are boiled under pressure, preferably in the presence of free lime or similarly active alkali, in suitable strength treating solutions of

loosely combined sulfur, such as soluble polysulfides of the alkaline earths. The polysulfides are formed by adding to water several per cent of an alkaline earth and then adding 20 to 40% of finely divided sulfur.

80. Drewsen, Viggo. Paper fiber from cornstalks. U. S. patent 1,229,422 (June 12, 1917).—*C. A.* 11, 2276.

Crushed bagasse or cornstalks is boiled in a suitable digester for 4 to 8 hours under a pressure of 40 to 120 pounds per square inch in an aqueous solution of a suitable monosulfite (such as the sodium salt), the solution preferably being strong enough to effect the desired disintegration of the material; 25% of sodium monosulfite (on the basis of the dry weight of the raw fibrous material) gives good results with ordinary grades of cornstalks.

81. Dryden, E. C., Aronovsky, S. I., and Jarrell, T. D. Utilization of wastes for paper and board making. *Paper Ind.* 21, 972–9 (1939).—*B. I. P. C.* 10, 172; *C. A.* 34, 2597.

Bagasse consists of the fibrous portion of the sugar cane stalk which remains after the extraction of the juice. Continental United States produces about 500,000 tons a year and Puerto Rico and the Hawaiian and Philippine Islands produce annually about 2,800,000 tons. This material accumulates at the mill during the sugar extraction process and must be disposed of in some manner. Originally it was simply stacked in huge piles and burned. Later, it was discovered that it could be used as fuel under the boilers in the mill for producing steam. However, since it is decidedly inferior as a fuel, it would be advantageous if oil could be substituted for the bagasse and the latter disposed of in some other way. This has led to many attempts to utilize bagasse in making paper or board. The chief advantage of bagasse over other agricultural wastes is that it involves no great problem of collection. The costs of collecting, crushing, and washing the material are borne by the sugar extraction process and the bagasse, when delivered to the paper or board mill thus requires no further preliminary treatment before pulping. It has been found that, properly baled and stored, bagasse will keep in good condition for at least a year. The manufacture of paper from bagasse has been studied with reference to the soda and sulfate processes and it has been found that book and writing paper of good quality can be made by the soda process. A lime-cooked bagasse pulp, when treated with asphalt, produces a good weather-resistant mulch paper. Such a paper has been made commercially in Hawaii, where it has been used with success in mulching the sugar cane and pineapple crops. The most important use found for bagasse thus far is in the manufacture of structural insulating board. It is claimed that one ton of bagasse yields approximately 3,000 square feet of insulating board (Celotex). A bagasse insulation board has also been manufactured in Hawaii. In Cuba a new process for milling sugar cane was developed with the particular object of leaving the fiber in a better physical state for board production (the Vazcane process). Another process consists of treating bagasse with dilute nitric acid, followed by washing and further treatment with dilute alkali. This method requires no pressure digestion but the acid treatment must be carried out in acid-resistant equipment. An easy-bleaching pulp can be prepared, which can be used, after further purification, in making rayon and other cellulose derivatives. Alcoholic nitric acid has certain advantages over aqueous solutions, resulting in higher yields of pulp with a lesser degree of degradation. The general question of the economics of agricultural wastes is considered.

82. Dyo, Suisen. Studies on the utilization of bagasse waste liquor. I. Utilization as a fertilizer. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 13, 201–11 (1941).—*C. A.* 42, 2381.

Waste liquor from magnesium bisulfite-treated bagasse, abundantly available from the sugar-refining industry in Formosa, was tried as a fertilizer for potted plants and grains in fields with a shale soil (pH 6.7) and fertilized with 0.9% potassium sulfate, 21% ammonium sulfate, and 19.5% superphosphate of lime. The addition of the waste liquor in quantities of 80 cc. per 12 kg. of soil induced more rapid growth and a greater yield, 10 to 30 cc. being the optimum. Beyond 100 cc., the effect became harmful.

83. Edmonds, R. W. Book and writing paper likely to become an important by-product of southern sugar industry. *Mfrs.' Record* 90, 63–4 (1926).

84. EGER, ERNST. Construction board. U. S. patent 2,550,143 (April 24, 1951).—*C. A.* 45, 5902.—*B. I. P. C.* 21, 743.

Fibrous material, such as bagasse and the like, is mixed with an aqueous mixture of dispersed Neoprene (polymerized chloroprene), dissolved partially condensed resorcinol-formaldehyde resin, and sodium hydroxide. The mixture sets to a friable solid gel, after which water is removed by drying. Pressure is not applied. Other aldehydes (acetaldehyde, propionaldehyde, or butyraldehyde) can be used. Other latices can be used. The board is used for paneling, heat insulation, or sound deadening.

85. ELLIS, HARRY E. Apparatus and process for producing pulp. U. S. patent 1,344,625 (June 29, 1920).

The invention covers a machine for crushing and shredding such material as bagasse, bamboo, canes, and reeds, the shredded material then being ground between the adjacent flat faces of basalt lava stones, preferably circular and of any suitable diameter. The upper stone is fixed and the lower stone runs horizontally. The material is fed between the stones with a sufficient quantity of water through an opening in the center of the upper stone so that, as material is ground, the pulp will be discharged by centrifugal force around the periphery of the stones. This pulp has sufficient fiber for the manufacture of paper without the mixture of other fiber, whereas the pulp heretofore made requires the addition of other pulp. By adjustment of the upper stone it is possible that the shredded material may be ground coarse, fine, or medium. Details of the apparatus are given.

86. EMILIANA, EZIO. Industrial utilization of sugar sorghum in Italy. *Anales soc. cient. argentina* 51, 8–24 (1951).—*C. A.* 45, 7809.

A discussion is given of the use of sorghum as a raw material for the production of sugar, alcohol, and paper.

87. FAIRWEATHER, H. G. C. Process and apparatus for obtaining simultaneously sugar and pulp from sugar cane. British patent 314,174 (May 4, 1928).—*T. S.* 91, 47. Cf. No. 417.

Sugar cane is ground or abraded into individual fibers or aggregates of relatively few fibers for removal of sugar in the presence of a liquid, the pulp obtained being suitable for papermaking. A hopper contains the sugar cane which comes in contact with a grindstone running in a receptacle containing a solvent liquid, preferably distilled water from the condensed vapors from the evaporators in the sugar house. The pulp, after screening, passes to an agitator or mixing box containing blades. The overflow from the box passes into a separator in which a cylindrical screen revolves, partially submerged in the pulp, so that the liquid passes through the screen and is drawn off through an opening while the solid portion of the pulp is deposited on the screen, carried out of the bath and scraped by doctors into a second mixing box. Any number of separators and mixing boxes may be used, fresh water being directed into the last mixing box and from the first separator the strong sugar solution is discharged through a pipe to the grinder, where it is sprayed uniformly over the surface of the grindstone. The pulp is discharged from the last separator into a conduit whence it may be taken directly to a paper mill.

88. Fibers. Sugar cane. *Papeterie* 54, 66, 69–70, 73–4 (1932).

The discussion includes botanical characteristics, culture, and a nontechnical consideration of the use of bagasse as a papermaking material.

89. Fibre "concentrates" from bagasse. *World's Paper Trade Rev.* 109, 1734, 1736 (1938); *B. I. P. C.* 8, 414.

A description is given of the Ritter pretreatment process for making fiber concentrates for pulp, boards, etc. from bagasse; *see* E. A. Ritter, U. S. patent 2,193,493 (No. 333). The main advantages of the process are: It acts as a preservative in quickly decaying materials. It greatly facilitates transport by making a fiber concentrate with an inexpensive plant (machinery) where the raw material is collected. A concentrate needs only half the chemicals which would otherwise be needed for digestion purpose in making paper pulp. A digester gives a much higher yield when using concentrates, because of the much higher cellulose content of the concentrate compared with the original raw material. Pulp made from the concentrates obtained from raw material high in pectose is made "freer" and cleaner and bleaches more readily. Pulp suitable for insulating boards or cardboards can be made without any boiling. The cost of the process is between

6s. 6d. and 10s. per ton of baled and dried concentrate, based on an annual minimum output of 10,000 tons; the cost of such a plant would be £10,000. The noncellulosic materials which are removed are suitable as a fertilizer.

90. FOSTER, JOHN P. Pulping process for bagasse. U. S. patent 2,013,042 (Sept. 3, 1935).—*T. S.* 103, 69; *C. A.* 29, 7075.

It is stated that the yield of alpha-cellulose from bagasse can be markedly increased and the expense of bleaching such cellulose greatly decreased if the raw material is treated with both alkaline and acid reagents; the process is characterized by a three-stage chemical treatment involving the use of alkalies and nitric acid. The first stage is a treatment with 0.5% sodium hydroxide (or 1% sodium carbonate or a mixture of the two) for 1–3 hours at about 160° F.; after washing in the container, the bagasse is steeped for 2–4 hours in 2% nitric acid at about 160° F.; after thoroughly washing with water, the product is subjected to a 5% solution of sodium hydroxide or carbonate (or a mixture of the two) for 3–6 hours at 120° F. The material is finally bleached with a 1–3% solution of calcium or other hypochlorite. An apparatus is illustrated for carrying out the operations and a beating engine specially designed for treatment of bagasse is described.

91. FOSTER, JOHN P., and JOACHIM, HERMAN L. Process of liberating cellulose from bagasse. U. S. patent 2,181,785 (Nov. 28, 1939).—*C. A.* 34, 2171.

The invention covers as a step prior to alkaline fiber liberation, the treatment of bagasse with a cane-wax solvent and dilute nitric acid. This may be conducted batch-wise but it is preferable to conduct it in a continuous manner, the bagasse flowing continuously from the point of introduction, through the preliminary treatment stages, to alkaline digestion tanks. The wax solvent may be toluene, benzene, carbon tetrachloride, acetone, or alcohol-ether mixture, but it is preferred to use aqueous solutions of wetting agents (any of the well-known compounds), about 4 pounds of wetting agent being used for 4–5 tons of dry bagasse; the concentration of the wetting agent is about 1 part by weight to 2600 parts by weight of the dilute nitric acid solution. The nitric acid has a concentration of 2.5–3% and is used at a temperature of 160° to 180°. This solution is used in the ratio of about 2800 pounds of solution per ton of bagasse.

92. FOWLER, G. J., and BANNERJEE, B. Production of power alcohol and paper pulp from bagasse. *J. Indian Inst. Sci.* 4, pt. 15, 241–60 (1921).—*T. S.* 75, 60; *C. A.* 16, 1504.

The best conditions for the hydrolysis of bagasse are 0.35–0.5% sulfuric acid and a ratio of acid to fiber not exceeding 6% of the weight of the latter. A large proportion of acid tends to destroy the fiber and to produce nonsugars which interfere with subsequent fermentation. The maximum yield was obtained in 15–30 minutes but there was not much loss when the heating was prolonged to 2 hours. The pressure used was 65 pounds per square inch. The best yield was 36% of sugar recovered, of which about 30% is calculated as being produced by hydrolysis of the cellular tissues. The sugar solution obtained was not readily fermented, even after clarification with lime. However, a large percentage of it can be fermented when diluted with an ordinary fermentable solution of sugar. The net yield of alcohol was from 8 to 9%, which compares favorably with results obtained from wood waste. The fibers obtained under favorable conditions of hydrolysis of bagasse can then be pulped by heating under pressure with sodium hydroxide and form quite satisfactory material for the manufacture of the cheaper and thicker grades of paper and for mixing with the better grades of pulp.

93. FRANCK, ERICH JOSE Process for the production of cellulose and hydrocarbons from sugar cane sprouts and refuse and burnt and frozen cane. U. S. patent 1,832,375 (Nov. 17, 1931).

This patent refers to the use of waste products, other than bagasse, such as sprouts, and burnt or frozen cane. A mixture of 100 kg. of the material, 800 liters of water, 2 kg. calcium sulfide and 2 kg. of sodium carbonate or sodium hydroxide is stirred from 4 to 24 hours; a solution of 1.5 kg. of saltpeter, 1.5 kg. of sodium carbonate and 4 kg. of sodium chloride in 400 liters of water is added and the mixture stirred for 1–2 hours while it is heated to a temperature of 100°C. Finally 4 kg. of sodium or calcium sulfite and 3 kg. of ammonium sulfite are added and the boiling is continued for 1–2 hours. The carbohydrates are obtained by evaporation of the resulting liquors.

94. FREEMAN, W. G. By-products of the sugar-cane industry. *Bull. Imp. Inst.* 30, 36–54 (1932); *Paper-Maker* 83, 430–1 (1932).

A review is given of the use of bagasse for paper, artificial silk, and fiberboard (Celotex, Vazcane). Other uses for bagasse are indicated (e. g., feedingstuffs, explosives, and charcoal).

95. FREISE, F. W. Fiber board manufacturing problems for Brazilian sugar factories. *Intern. Sugar J.* 32, 245–6 (1930); *Wochbl. Papierfabr.* 62, 669–70 (1931).—*T. S.* 94, 110, 164.

This is largely a discussion of the economics of the sugar cane industry in Brazil. The sugar cane contains 74% water, 11% sugar, 14% fiber, and 1% ash. The bagasse contains about 0.75% sugar and 25–33% water. The value as fuel is considered and compared with coal and oil. The fibers are 5–25 mm. long; the manufactured board is usually 1.22 m. wide and 7 to 12 mm. thick; the sp. g. is about 0.3.

96. FRITCH, SYLVESTER. Process of producing fiber. U. S. patent 432,825 (July 22, 1890).

A method for treating sugar cane and similar materials for the manufacture of textile fabrics, twine, rope, paper, etc., consists in crushing the plants, allowing them to remain for 24 hours in a solution of one pound of sulfuric (or other acid) in 50 gallons of water, and pressing the stalks between rollers which removes the pith, and finally heating with a solution of 3 pounds of unslaked lime, 1 pound of magnesium oxide, 1 pound of potassium carbonate and 0.25 pound of olive or other fixed oil in 75 gallons of water for 1 hour, after which the fibers are washed with a solution of an ammonium soap.

97. FROST, B. M., and SUKMANOWSKY, E. Pulp and paper trade statistics of the other American Republics, 1938–1941. *Dept. of Commerce, Bureau of Foreign and Domestic Commerce, Economic Series 35.* 1944. 88 p. Processed.

Argentina—A new paper mill in Santa Fé which entered production in 1943, utilizes bagasse as a raw stock. Cuba—No wood pulp is produced in Cuba, although efforts have been made to manufacture a pulp suitable for papermaking from sugar cane bagasse, large quantities of which are locally available. Two mills have been erected and machinery for pulp making installed but neither has advanced beyond the experimental stage of production, and both are now closed down. Peru—Papermaking stocks utilized by the mills include bagasse pulp manufactured by one of the mills. Bagasse pulp manufactured in Peru has climbed steadily from less than 800 tons in 1940 to more than 2,600 tons in 1942. The 1943 output is expected to reach close to 5,000 tons.

98. FULLER, CHARLES W. Apparatus for drying bagasse. U. S. patent 2,481,305 (Sept. 6, 1949).—*B. I. P. C.* 20, 135.

A tower is provided for drying wet bagasse and like material for use as fuel or for the manufacture of paper and board.

99. GANS, LOUIS R. Cellulose. French patent 943,617 (March 14, 1949).—*C. A.* 45, 2206.

Bagasse is pulped by heating with seven times its weight of a solution containing 2.5% sodium hydroxide and 1.5% of sodium sulfide at 170 to 173° for 15 minutes. After washing and bleaching, the product contains more than 90% alpha-cellulose and less than 5% pentosans.

100. GILL, SAMUEL A. Process of making cornstalk fiber composition. U. S. patent 1,814,751 (July 14, 1931).

A molding composition is formed of 8 parts of cornstalks or cane fiber, 30 parts of asbestos fiber, and 2 parts of sawdust or wood flour; the binder consists of 15 parts of celluloid dissolved in 36 parts of acetone and 9 parts of gold size or banana oil. The fiber is 40% and the binder 60% of the molding product.

101. GOLDSMITH, W. F. Hawaii's new insulation board plant possesses many advantages. *Paper Trade J.* 95, no. 17, 19–21 (1932).

In 1932, Hawaiian Cane Products, Ltd. opened a mill at Hilo, Hawaii, for the manufacture of Canec, a cane fiber structural insulation. The bagasse (approximately 55% bone dry) is screened (Rotex screens), the fine material or pith is discarded, and the remainder is separated into two sizes (coarse and fines). Fourteen-foot globe rotary digesters are employed for cooking, which is carried out

at a temperature equivalent to 60 pounds pressure for about 3 hours. The liquor is removed in drain bins, after which the pulp is freed of metallic impurities by magnetic separators and refined in Bauer refiners and thickened on an Oliver thickener. Rosin size is added in the stock chest, after which the pulp passes through Claflin refiners to mixing tanks, from which it flows to the Oliver board machine. Finally, the boards pass through a Downington press equipped with five pairs of rubber-covered rolls, and then an eight-deck Coe drier 390 feet long (before drying, the board is cut into lengths of 6 to 12 feet).

102. Gomez, Lilly, and Aguila, Geminiano O. Pulping bagasse by chlorination method. *Univ. Philippines Nat. and Applied Sci. Bull.* 7, 227–31 (1939).—*C. A.* 34, 3081.

Laboratory pulping experiments with bagasse from several sources, in which chlorine gas and a dilute sodium hydroxide solution followed by sodium hypochlorite bleaching were used, gave a 37% yield of pulp with an alpha-cellulose content (about 76.5%) too low for satisfactory use for rayon production. Complete chemical analyses of the bagasse and the resulting pulp are given.

103. Gore, Frederick E. Method of cooking cellulose fiber. U. S. patent 725,071 and 725,072 (April 14, 1903).

In pulping wood, bagasse, and like materials with caustic liquor, the liquor is transferred from the fiber into reactive contact with a decarbonating material (such as hydrate of lime), filtered, and returned to the fiber, thereby sustaining the efficiency of the liquor during the cooking process.

103A. Grace Company using cane sugar for paper manufacture. *Paper Mill News* 73, no. 46, 49 (Nov. 18, 1950).

Mention is made of the process (no details are given) used by W. R. Grace and Company for the manufacture of paper from bagasse at Paramonga, Peru. Among the products mentioned are airmail paper, bag papers, wrapping papers, and corrugated boards. See also *Business Week*, May 12, 1951:164.

104. Griffin, R. B., and Little, A. D. The chemistry of paper-making. New York, Lockwood, 1894.

On page 132 the authors state: Bagasse and sorghum "are easily reduced by boiling with weak soda, and the resulting pulp is much like that from straw. On account of the large proportion of pith the yield of fibre is only about 25 percent on the dry stalk, and the samples which we have seen were so badly specked by fragments of seed hulls as to be useless for making any but the cheapest papers."

105. Groud, Ch. Bagasse paper. *Papier* 24, 226–8 (1921).—*C. A.* 15, 2546.

A brief discussion is given of the suitability of bagasse as a source of paper.

106. "Gruco" method of pulp production. *Indian Pulp and Paper* 4, 358–62, 398–9 (1950).—*B. I. P. C.* 20, 774.

Details are given of a modified sulfate process (a Swedish development) which is suitable for the digestion of nonlignified plants (bagasse, straw, corn stalks, grass, and the like). Lower quantities of sodium hydroxide and sodium sulfide, lower temperatures, and a shorter cooking cycle (not exceeding four hours) than in the standard process are employed. Bagasse can be charged in a moist condition, provided allowance is made in the composition of the cooking liquor for the higher moisture content of the material. The cooking liquor may consist of a mixture of white and black liquor, although the use of white liquor alone is preferable for bagasse, straw, and grasses to avoid discoloration of the cooked pulp.

107. Hachihama, Yoshikazu, and Jodai, Sho. Lignin and related compounds. VI. Comparison of behavior of lignins isolated from softwood, hardwood, and grass in course of hydrogenation. *J. Soc. Chem. Ind. Japan* 46, 132–9 (1943).—*C. A.* 43, 2427.

To determine possible structural differences in lignin from various sources, lignin was isolated from Ezomatu (a softwood), beech, and bagasse, and catalytically hydrogenated. The decrease in hydrogenation pressure, the properties of the oils obtained, and the fractionation of the oils were studied and compared with each other and with dihydrodehydrodiisoeugenol, used as a model with a possible structural resemblance to lignin. The preliminary results indicated that the lignins were different and that phenols were the chief products of hydrogenation.

108. HACHIHAMA, YOSHIKAZU, and JODAI, SHO. Lignin and related compounds. VII. Phenols in the hydrogenation of hardwood and grass lignins. *J. Soc. Chem. Ind. Japan* 46, 132–9 (1943).—*C. A.* 43, 2427.

The phenolic products were isolated and identified. It was previously reported by the authors that Ezomatu yielded phenols containing a comparatively large quantity of dihydroeugenol. In the present case of hardwood and grass lignins phenols having the syringic group were also found. From this it is concluded that phenols which have a skeleton containing 4, 3-HO (CH_3O) $C_6H_3C_3$ are important in the structure of softwood lignin, whereas both this type and that containing the structure 4, 3, 5-HO $(CH_3O)_2C_6H_2C_3$ have structural importance in hardwood and bagasse lignins.

109. HACHIHAMA, YOSHIKAZU, and JODAI, SHO. Lignin and related compounds. VIII. Phenols in hydrogenation products of lignin. *J. Soc. Chem. Ind. Japan* 46, 132–9 (1943).—*C. A.* 43, 2428.

The higher boiling phenols were methylated, oxidized, and finally characterized as the corresponding acids. Guaiacyl and syringyl groups were found in the hardwood and grass lignins, with only guaiacyl groups present in the softwood product.

110. HACHIHAMA, YOSHIKAZU, JODAI, SHO, SAWAI, KIYOSHI, and NAKAYAMA, MORIYUKI. Hydrogenation decomposition of Buna wood and bagasse. *J. Soc. Chem. Ind. Japan* 47, 218–20 (1944).—*C. A.* 43, 8675.

Buna wood and bagasse flours were catalytically reduced with Raney nickel catalyst. They were completely liquified and yielded pale yellow, transparent solutions. Since the reaction temperature was low, a low-degree polymerized lignin was obtained.

111. HACHIHAMA, Y., ONISHI, M., and TAKEMURA, W. Bagasse. VIII. Action of dilute nitric acid on bagasse. *J. Soc. Chem. Ind. Japan* 38, 690–1B (1935).—*T. S.* 103, 355; *C. A.* 30, 2751.

Bagasse (2 grams) was treated with 20 cc. of 1–6% nitric acid for 0.5–2.5 hours at 80–100° C. The amounts of lignin and pentosan in the residual pulp were determined. The lignin, isolated by the sulfuric acid method, from bagasse treated with nitric acid had a yellowish color and contained 3–4% nitrogen. Nitration of isolated bagasse lignin with 5% nitric acid for 1 hour at 100° C. gave a brownish amorphous substance containing 2% nitrogen and 14% methoxyl groups. The nitrated lignin differed from the original lignin mainly in its increased solubility in various solvents. The acid-treated bagasse was digested with 0.5–3% sodium hydroxide for 0.5–4 hours at 80–120° C. The maximum extraction of lignin and pentosans was found with 3–5% nitric acid at 100° C. for one hour, followed by treatment with 2% sodium hydroxide at 100° C. for one hour.

112. HACHIHAMA, Y., ONISHI, M., and TAKEMURA, W. Bagasse. IX. Preparation of bagasse pulp by the nitric acid process. *J. Soc. Chem. Ind. Japan* 39, 239B (1936).—*T. S.* 104, 230; *C. A.* 30, 8609.

The bagasse was crushed, passed through a 0.5-cm. mesh screen, digested for 2 hours at 95° C. with 3% nitric acid or for 1 hour with 4% nitric acid, washed with water, and treated with 1% sodium hydroxide for 1 hour at 95°. The amount of acid and alkali solution was ten times the weight of dry bagasse. The actual consumption of nitric acid was 18.7 and 19.4% on the basis of the dry bagasse for 3 and 4% acid, respectively; 37–38% of soft, easily bleachable pulp were obtained. The bleached pulp showed 88–89% of alpha-cellulose, 7–9% of pentosans, a copper number of about 1, and an ash content of about 1%. During the digestion, 0.23–0.7% (on the basis of the dry bagasse) of hydrocyanic acid was evolved. *p*-Hydroxy-*m*-nitrobenzaldehyde was isolated from the waste acid, and oxalic acid, nitrolignin, and xylose were also found. The soda, sulfate, and neutral sulfite processes were tried with the same material, but they gave pulps of poorer quality, having a pentosan content of 23–31% and showing a greater consumption of active chlorine.

113. HACHIHAMA, Y., and TAKEMURA, W. Bagasse. XII. Bagasse pulp prepared by the nitric acid process (supplement). *J. Soc. Chem. Ind. Japan* 40, 355B (1937).—*C. A.* 32, 1449.

Mean fiber length, 1.248 mm., diameter 18.7 mu. The viscosity of bagasse pulp prepared by the nitric process is lower than that prepared by the soda, sulfate, or sulfite processes.

114. HAGIWARA, T. Manufacture of paper pulp from bagasse and similar materials. U. S. patent 1,825,349 (Sept. 29, 1931); Japanese patent 91,913 (June 23, 1931).—*T. S.* 94, 321; *C. A.* 26, 308, 3668.

Bagasse and other fibrous materials are digested under pressure at a temperature of 100–115° C. for 30–40 hours with a solution containing mainly magnesium bisulfite, with a small quantity of magnesium sulfite in order to prevent the presence of free sulfurous acid.

115. HALE, FRANKLIN D. Megasse and bamboo paper. *Paper* 3, no. 4, 20 (1911); *World's Paper Trade Rev.* 57, 1104 (1912).

This news item gives information similar to that contained in the article by Carmody (No. 54).

116. HAMAGUTI, EIZIRO, MIYAKE, SUGURU, and ONO, KAZUKI. Utilization of bagasse. II. The action of dilute sulfuric acid on raw bagasse and the preparation of rayon pulp by the soda process from bagasse treated with dilute sulfuric acid. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 11, 309–21 (1939); *Cellulose Ind.* (Tokyo) 16, 193–204; Abstracts (in German) 27–8 (1940).—*B. I. P. C.* 11, 41; *C. A.* 34, 7136.

Treatment of bagasse with 0.05% sulfuric acid under 4 atmospheres pressure for 30 minutes gave 74.8% of a product containing 16.6% pentosans. The product was digested with 2.2% sodium hydroxide under 4 atmospheres pressure for 1 hour and bleached with chlorine and bleaching powder. The yield of bleached pulp was 37.2%. The pulp contained 91.8% alpha-cellulose, 7.85% beta-cellulose, 2.34% gamma-cellulose, 10.25% pentosans, 0.27% ash, and 0.22% lignin. The copper number was 1.21 and the viscosity was 2.87. The digestion of bagasse required 11% of sodium hydroxide. The pretreatment saved sodium hydroxide and prevented putrefaction of the bagasse during storage.

117. HAMAGUTI, EIZIRO, MIYAKE, SUGURU, and ONO, KAZUKI. Utilization of bagasse. III. Manufacture of rayon pulp from bagasse and its spinning. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 12, 9–16 (1940); *Cellulose Ind.* (Tokyo) 16, 233–7; Abstracts (in German) 29–31 (1940).—*B. I. P. C.* 11, 392; *B. C. P. A.* 1941B, II, 146; *C. A.* 35, 1988.

When bagasse was heated with 0.04% sulfuric acid at 150° for 30 minutes and then digested with about 2% sodium hydroxide at 150° for 1 hour, a superior quality of rayon pulp was obtained. The pentosans in the bagasse were removed easily by treatment with dilute sufuric acid. The yield of pulp was 30–33%. It contained 92% of alpha-cellulose, 0.3% of ash, and the copper number was 1.9. Rayon was prepared from the bagasse pulp as well as from wood pulp. A sample of rayon showed the following properties: denier 83.7, tensile strength 1.75 gram/denier in the dry state and 0.86 in the wet state, elongation 27.9% in the dry state and 8% in the wet state.

118. HAMAGUTI, EIZIRO, MIYAKE, SUGURU, and ONO, KAZUKI. Utilization of bagasse. IV. Manufacture of paper pulp by the soda process from bagasse treated with dilute acid. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 12, 17–27 (1940); *Cellulose Ind.* (Tokyo) 16, 262–71; Abstracts (in German) 33–4 (1940).—*B. I. P. C.* 11, 392; *C. A.* 35, 1989.

Bagasse was heated with 0.023% sulfuric acid at 150° for 20 minutes and then with sodium hydroxide (12% on the weight of the bagasse) at 150° for 1 hour. A pulp suitable for papermaking was obtained, with the following analyses: alpha-cellulose 87.5%, pentosans 16.4%, ash 0.45%, and copper number 0.99.

119. HAMAGUTI, EIZIRO, MIYAKE, SUGURU, and ONO, KAZUKI. Utilization of bagasse. IX. A characteristic seen in the maturing of rayon pulp from bagasse in the preparation of rayon. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 13, 280–2 (1941).—*C. A.* 42, 3175.

The rayon pulp from bagasse [11% water and 91.3% α-cellulose (on basis of dry pulp); viscosity 3.65 by the cuprammonium method] matured 24 to 36 hours earlier to rayon than viscose pulp (water content 10.1%, α-cellulose content 90.2%, viscosity 4.27).

120. HAMAGUTI, EIZIRO, MIYAKE, SUGURU, and ONO, KAZUKI. Utilization of bagasse. X. Preliminary report on semi-industrial preparation of rayon pulp from bagasse. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 14, 1–4 (1942).—*C. A.* 42, 3175.

By cooking 173 kg. bagasse with 572 grams sulfurous acid and 22.5 kg. commercial sodium hydroxide, treating the chlorinated pulp (1363 cc. chlorine) with

757 grams sodium hydroxide, and bleaching with 2271 grams bleaching powder (33% effective chlorine), 35.1% rayon pulp were obtained containing 93% α-cellulose, 5.32% β-cellulose, 0.45% γ-cellulose (on dry basis), 5.1% pentosans, and 0.64% ash; the copper number was 0.38 and the viscosity 3.6.

121. Hamaguti, Eiziro, Miyake, Suguru, and Ono, Kazuki. Utilization of bagasse. XII. Recovery of soda from soda black liquor and hydrolysis with the recovered white liquor. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 14, 304–11 (1942).—*C. A.* 42, 3175.

The black liquor obtained by boiling 100 grams of bagasse and 12 grams sodium hydroxide contained 9.4 to 9.8 grams of sodium oxide. The combustion loss was small (organic matter 43 grams). The recovery of sodium hydroxide as white liquor was 98.4%. This white liquor, with the addition of sodium hydroxide to replace the loss, could be used five times in succession for the pulping operation without affecting the quality of the pulp produced. The sodium hydroxide loss per boiling unit of 12.28 grams was 0.48 to 0.72 gram (average, 0.63 gram). The pulp yield was 53%.

122. Hamburg, Herman. Manufacture of articles such as boards and sheets from fibrous organic materials. Canadian patent 473,674 (May 15, 1951).—*B. I. P. C.* 22, 61.

A process is described for the manufacture of hard, moisture-resistant molded board from fibrous vegetable waste (e. g., sawdust, shavings, straw, bagasse, and the like). The material is mixed with ten times its weight of 1.5% sodium hydroxide solution and treated for three hours at a steam pressure of 40 pounds per square inch. The digested material is washed free of the alkali and sufficient water is removed mechanically to reduce the water content to 50%. The pulp mass is impregnated with a 5% calcium hypochlorite solution and aluminum sulfate is added to reduce the pH to 4.5. The resultant stock is suitable for shaping in accordance with standard practice.

123. Hanauseck, T. E. Sugar cane paper. *Papier-Fabr.* 9, 245, 274 (1911); *Paper* 4, no. 12, 11 (1911).

A brief description is given of the microscopic appearance of the sugar cane fiber.

124. Harang, Theophile. Apparatus for the disintegration of bagasse and other vegetable matter. U. S. patent 278,545 (May 29, 1883).

An apparatus is described in which bagasse may be treated with steam, lime, and soda.

125. Harreveld, J. van. Celotex, a product from bagasse. *Arch. Suikerind.* 32, 537–41 (1924).—*C. A.* 19, 189.

A number of factories in Java now have an excess of bagasse; this might be utilized either for the manufacture of paper or of Celotex.

126. Havik, H. G. Raw materials for pulp and paper manufacture from Java. *Papier-Fabr.* 9, 274–7 (1911).—*J. Soc. Chem. Ind.* 30, 352.

The bagasse from Cheribon sugar cane was boiled for 4 hours at 2–3 atmospheres with 20% sodium hydroxide (calculated on the dry weight of the bagasse). The yield of unbleached pulp was 32%. The sulfate process may be suitable for digesting this material. The paper samples were 0.13–0.5 mm. thick, weight per square meter 120 g., 12% moisture, breaking length 8300 meters, folding endurance, more than 1000 double folds on Schopper machine. The average length of the fibers was 1.5 mm., the average width 17 microns.

127. Hawaiian Sugar Planters' Committee. Manufacture of sugar and utilization of by-products. 1913.

128. Hay, Harold R., and Lathrop, Elbert C. Storage of crop fibers and preservation of their products. *Tech. Assoc. Papers* 24, 412–18 (1941); *Paper Trade J.* 112, no. 9, 29–34 (1941); *Paper Ind.* 23, no. 1, 70, 72, 74, 76 (1941).—*B. I. P. C.* 11, 227; *B. C. P. A.* 1941B, II, 180.

Adequate storage and product preservation of crop fibers constitutes an important step in the extended utilization of approximately one hundred million tons of annually replenished fibrous cellulosic raw materials. Storage preservation is attained by minimizing exposed surface, preventing undue inclusion or entrance of water in storage piles, and controlling by specific chemical or biological means, those organisms which weaken the fiber. Bagasse is commercially stored

by using a controlled fermentation process which limits growth of organisms and dries out the fibers. Chemicals used for the preservation of wood and for the preservation of defibered cellulosic materials are not readily interchangeable. For felted fibrous products, efficient use is made of relatively insoluble powders, flocculent precipitates, emulsions, and chemicals capable of absorption by lignocellulose.

129. Heim, F., Maheu, J., and Matrod, L. Papermaking qualities of bagasse. *Papeterie*, 42, 539–43, 578–87 (1920); *Paper* 27, no. 2, 11–4, 36 (1920); *Bull. synd. fabr. papier carton France*, no. 9, 135–6 (May 15, 1920).—*C. A.* 14, 2553, 2856.

The micrography of bagasse pulp is discussed and drawings of the fiber and of a cross section are given. The behavior of the fiber with various stains is also reported. The yield of pulp (soda process) was about 30%. The nature of the pulp is such as to make it promising as a filler in papermaking. The raw material contains 8.5% moisture, 2.5% ash, 0.52% waxes and fats, and 39.3% cellulose. The cellulose contents of the unbleached and bleached pulps were 90 and 92%, respectively. The paper was slightly colored, somewhat satiny to the touch, had a certain firmness, a satisfactory tensile strength and resistance to crumpling, and a slightly low tearing resistance.

130. Heritage, Clark C., and Van Beckum, William G. Process for producing lignin products. U. S. patent 2,541,059 (Feb. 13, 1951).—*B. I. P. C.* 21, 513.

A method is described for the separation of lignin from lignocellulosic materials (e. g., wood, corn stalks, straw, bagasse, and the like) by extraction with sodium hydroxide. The method of extraction is covered by U. S. patent 2,541,127 (Feb. 13, 1951) to Van Beckum.

131. Herz, Ludwig. Process of treating vegetable and textile fiber, waste paper, wood waste and the like for conversion into paper material. U. S. patent 1,041,791 (Oct. 22, 1912).

Bagasse and similar material are soaked with a solution containing 8 grams of caustic soda per liter to which may be added 0.01 liter of ammonium hydroxide to prevent a possible crystallization of the soda. It is then passed between rollers to a churn or centrifugal machine, where it is disintegrated and washed free of the soda. The material may also be stirred in the soaking vessel to begin the work of disintegration. The resulting mass can be further refined by beating and bleaching. If desired for an insulating medium, 200 kg. of the mass are treated with 0.5 kg. of chromic acid and 4 kg. of size.

132. Hessey, R. W. G. Bagasse—a chemurgic raw material. *Proc. Queensland Soc. Sugar Cane Tech.* 1942, 67–79.—*C. A.* 36, 5376.

Known uses of bagasse are reviewed. New analyses (two series) on whole bagasse gave: ash, 2.5, 2.5; alcohol-benzene extract, 3.2, 4.4; pentosans, 24.3, 21.8; lignin 21.7, 21.7; Cross and Bevan cellulose 57.2, 50.0; alpha-cellulose, 32.5, 28.0%. Experiments are reported on the preparation of cellulose pulp by the nitric acid method: the bagasse is shredded and the fraction 4- to 20-mesh (50 grams) was boiled under a reflux with 750 ml. of 2% nitric acid for 4 hours; the residue was boiled 1 hour with 500 ml. of water and 400 ml. of a 4% solution of sodium hydroxide. After washing, the crude pulp was treated at room temperature with a 9% solution of sodium hydroxide for 20 minutes, washed, suspended in a saturated solution of chlorine for 10 minutes and, after washing, was boiled for 20 minutes with a 2% solution of sodium sulfite. The pulp contained 97.7% of Cross and Bevan cellulose, 91.9% of alpha-cellulose, and 0.75% of ash. The ash content of the purified pulp is closely related to the ash content of the bagasse, which is more or less variable. The yield of pulp is also more or less a variable characteristic, ranging from 32 to 34.8%. Experiments (not described) showed that the pentosans of bagasse may be converted into furfural, with either the coarse or the fine material. The production of a bagasse plastic and furfural may be combined in the operation of hydrolyzing the bagasse by the acid process.

133. Higgs, A. C. Wallboard manufacture. *Proc. Australian Pulp Paper Ind. Tech. Assoc.* 3, 294–318 (1949).—*B. I. P. C.* 20, 851; *C. A.* 44, 8651.

A description is given of the manufacture of low density insulating board, semihardboard, and hardboard from Australian raw materials—hardwoods and megasse (bagasse). Stock preparation is carried out in rotary digesters, Bauer-type attrition mills, and the Asplund Defibrator; sheet formation, drying, and finishing operations are described.

134. HOCHE, ADAM. Pulp process. U. S. patent 2,058,792 (Oct. 27, 1936).

The raw material is saturated with dilute (1 to 10%) sulfuric acid and is treated with the product formed by bubbling chlorine gas and sulfur dioxide through acetic anhydride. The reaction is carried out in a series of digesters so that the gaseous product is exhausted before the end of the system. The active pulping agent is considered to be sulfuryl chloride.

135. HOCHE, ADAM. Pulp process. U. S. patent 2,095,194 (Oct. 5, 1937).

The pulping agent consists of nitric acid with a concentration of from 40 to 45° Baumé. To facilitate reaction, from one to eight pounds of cane sugar, starch, or molasses per ton of cellulosic material are added. The reaction is carried out at atmospheric pressure and is complete in about 40 minutes. In the case of bagasse, sufficient sugar is present to cause the reaction to proceed at the proper rate.

136. HÖNIG, P. Progress in bagasse utilization. *Arch. Suikerind.* 41, 545–54 (1933).—*T. S.* 98, 272; *C. A.* 28, 926.

A résumé is presented of modern developments in the utilization of bagasse. The Pomilio process for the production of cellulose and the manufacture of paperboard from bagasse in Hawaii are described in detail.

137. HÖSSLE, F. VON, ET AL. Die Geschichte des Papiers. Die Roh- und Halbstoffe. Berlin, Elsner, 1929.

A microphotograph of the sugar cane fiber is given on page 75 and a discussion of the fiber may be found on pages 76–7 and 178–80. This discussion is confined principally to the work of Kumagawa and Shimomura (No. 174).

138. HOFMANN, CARL. Praktisches Handbuch der Papier-Fabrikation. Berlin, Verlag der Papier-Zeitung, 1897.

Bagasse is discussed briefly on pages 1641–2. The author states that, from 1867 to 1871, he pulped several tons of bagasse in the Public Ledger mill at Elkton, Maryland, using the method for straw; he found that bagasse required a larger amount of alkali than straw but yielded a softer pulp. The quality of the pulp is between that of esparto and straw. Its commercial value is questionable because of the high silica content.

139. HOFMANN, CARL. Sugar cane paper. *Papier-Ztg.* 36, 2221–2 (1911); 41, 967, 1566 (1916).—*C. A.* 5, 3621.

The possibility of bagasse paper competing with that made from wood pulp is discussed.

140. HOGGATT, W. B. Waterproofing and fireproofing fibrous materials such as pulp boards (from bagasse, etc.). U. S. patent 1,860,097 (May 24, 1932).—*T. S.* 95, 224.

The original board to be waterproofed or fireproofed is made from bagasse, cornstalks, or the like in any suitable manner.

141. HONDA, KOITIRO, and NAKAMURA, YUZURU. Blending material for bagasse pulp. *Rept. Govt. Sugar Expt. Sta., Tainan, Formosa* No. 6, 161–6 (1939).—*C. A.* 33, 7478.

To compensate for the shortness of the fibers of noble canes, it is proposed to mix bagasse of Glagah and Kassoer canes (sugar content 10%), the fibers of which are 1.5–35 mm. long.

142. HONDA, KOITIRO, and NAKAMURA, YUZURU. Pulp from bagasse by the soda process. *Rept. Govt. Sugar Expt. Sta., Tainan, Formosa* No. 6, 149–56 (1939).—*C. A.* 33, 7100.

After a pretreatment to render the material permeable, the bagasse is cooked with 3–4% soda solution at 5–6 atmospheres for 2–3 hours. The yield is 35–37% of cellulose containing 82–85% of alpha-cellulose, 7–12% of pentosans, and 1.5–2.5% of lignin. Soda consumption is 15–20% of the bagasse.

143. HONDA, KOITIRO, NAKAMURA, YUZURU, and MIMA, YOSITUGU. Pulp manufacture from bagasse by the soda process. II. Bleaching experiments. *Rept. Govt. Sugar Expt. Sta., Tainan, Formosa,* No. 7, 238–42 (1940).—*C. A.* 35, 5694.

The best quality of bleached pulp was obtained when the bagasse was cooked with 4% sodium hydroxide at 5 atmospheres pressure. The product contained 91.7% of alpha-cellulose with a viscosity of 25.

144. HONDA, KOITIRO, and NAKAMURA, YUZURU. Studies on pulp making from bagasse. IV. Utilization of the waste liquor. *Cellulose Ind.* (Tokyo) 17, 229–32; Abstracts (in English) 41 (1941).—*C. A.* 36, 2135.

From 438 grams of bagasse, pretreated with dilute hydrochloric acid and cooked with 15% soda at 4 atmospheres for 1 hour, 8 liters of waste liquor were obtained. From this 62.7 grams of soda lignin were precipitated by first acidifying with hydrochloric acid (to equal 2% hydrochloric acid concentration) and then heating at 95–100° for several hours. The amount of lignin recovered revealed a loss of 26.8 grams with reference to the lignin content of the bagasse (91.7 grams) and to that of the pulp prepared (3.2 grams). When the soda lignin was reprecipitated from acetone or glacial acetic acid solution, a pale brown amorphous powder, melting at 147–149°, was obtained. The product was soluble in sodium carbonate, methyl alcohol, ethyl alcohol, acetone, and glacial acetic acid; it gave a positive reaction for hydroxyl (aliphatic and aromatic), methoxyl, and carboxyl radicals. By distilling the soda lignin over a direct flame, an oily fraction (25.5%), an aqueous fraction (13.9%), and a residue (45.6%) were obtained. The oily distillate contained 16% of phenol and a small amount of cresol and xylenol.

145. HONDA, KOITIRO, NAKAMURA, YUZURU, AOKI, SIRO, GODA, HIDETOSI, and MIURA, YOSITUGU. Pulp manufacture from bagasse by the soda process. III. *Cellulose Ind.* (Tokyo) 16, 424–9; Abstracts (in English) 41–3 (1940).—*B. I. P. C.* 11, 392; *C. A.* 35, 5694.

In bleaching raw pulp prepared from bagasse with chlorine gas, various amounts of hydrochloric acid were produced which were related to the Roe chlorine value of the pulp. The following gives the amount of hydrochloric acid produced per 100 grams of raw pulp and the corresponding Roe values:

HCl:	*Roe value*
0.4375	1. 95
0.4739	2. 00
0.8021	2. 28
1.0212	2. 41
1.1302	2. 61
2.2085	5. 39
3.4272	6. 01

Hydrochloric acid can be produced during the bleaching by either substitution, addition, substitution and oxidation, or the reaction between chlorine and water. From the above figures, it seems that hydrochloric acid was produced by addition when the Roe values were low and by substitution and oxidation when the values were high. By utilizing this by-product of bleaching for the removal of pentosans while bagasse was being digested with 10–14% caustic soda per 100 grams of bagasse, the yield was 23–41% of raw pulp containing 80–92% of alpha-cellulose and 17–20% of pentosans. The raw pulp of highest yield, after bleaching, contained 92% of alpha-cellulose and had a viscosity of 29 and a tensile strength of 11 kg./sq. mm.

146. HORN, HARRY L. Method of preparing cellulose pulp. U. S. patent 1,779,971 (Oct. 28, 1930).—*C. A.* 25, 205; *T. S.* 93, 114.

The patent covers a digester for preparing pulp from bagasse and like materials which provides means for passing steam into the container filled with the shredded material and water (containing dissolved sodium chloride) and also means for passing an electrical current through the water, as well as a provision for beating the contents of the container. The first step consists in the action of the electric current for about two hours. The sodium chloride is a softening agent and, coupled with the electrical action, very efficiently softens the shredded bagasse. After this period, lime and soda ash are introduced into the container, followed by steam at a pressure of 30–50 pounds for 1–2 hours. The beating is carried out by means of rods within the digester.

147. HORN, HARRY L. Method of preparing cellulose pulp. U. S. patent 1,780,750 (Nov. 4, 1930).—*C. A.* 25, 205; *T. S.* 93, 114.

This patent covers the process of pulping bagasse with the digester covered by U. S. patent 1,779,971. Ten pounds of sodium chloride are added to 100 pounds of shredded bagasse in 100 gallons of water. The digester rotates 18 times per minute.

148. HORN, HARRY L. Electrolytic apparatus for using bagasse to make paper pulp. U. S. patent 2,446,418 (Aug. 3, 1948).—*B. I. P. C.* 19, 59.

This is an improvement over U. S. patent 1,779,971 (Oct. 28, 1930) [No. 146] and provides the container which holds the electrolyte and the bagasse with certain rigid electrical conductors arranged longitudinally of the container and upon which the electrodes are mounted. The current flows from these electrodes through the electrolyte to an interior shell of the container.

149. HUTCHINSON, T. J. Utilizing bagasse. *Moniteur* 45, 99–100 (1909).—*Auszüge* 1909, 73.

Bagasse contains 18.6% fiber bundles, 56.7% rind, and 24.7% of pith; each of the components contains about 50% of cellulose. However, the cellulose of the pith is very sensitive to alkali. Therefore, digestion must be carried out with a weak alkaline solution.

150. HUTCHINSON, THOMAS J. Treatment of bagasse. U. S. patent 975,387 (Nov. 8, 1910); British patent 20,266 (Sept. 11, 1907); French patent 394,670 (Sept. 11, 1908); *World's Paper Trade Rev.* 51, 12 (1909).—*J. Soc. Chem. Ind.* 28, 105, 325; *C. A.* 3, 1942; 5, 785.

The process involves two steps. In the first, the bagasse is treated with a 2.5–5% of sodium carbonate for about 30 minutes at about 100° C. or up to and under a steam pressure of 10 pounds. After thorough washing, the material is further treated with a 5–7.5% solution of sodium hydroxide at about the same temperature or steam pressure.

151. HUTCHINSON, THOMAS J. Treating the fibrous contents of bagasse. U. S. patent 1,003,606 (Sept. 19, 1911); British patent 23,655 (Nov. 5, 1908); *World's Paper Trade Rev.* 56, 1022–4 (1911).—*C. A.* 4, 2203.

An apparatus is described, the purpose of which is thoroughly to wash the material and to deliver it from the machine in a sheet or web which is either dried on the machine or as it passes therefrom, or which will subsequently easily dry. It consists of a series of tanks, fitted with beaters.

152. HUTCHINSON, THOMAS J. Manufacture of paper and material therefor. British patent 20,267 (Sept. 11, 1907).—*J. Soc. Chem. Ind.* 28, 106.

The purified bagasse fiber, produced by the mild process of British patent 20,266 (1907) is subjected to a second and preferably milder treatment of a similar nature, whereby 85–95% of a papermaking halfstuff is obtained from it. In this second treatment the purified bagasse fiber is boiled for about one hour under atmospheric pressure with a solution of 2.5–5% of caustic soda (on the air-dry weight of the material). By this treatment the fibers are sufficiently reduced for conversion into paper pulp by known methods.

153. HUTCHINSON, THOMAS J. Washing and other treatment of fibrous material and apparatus therefor. British patent 23,655 (Nov. 5, 1908).—*J. Soc. Chem. Ind.* 29, 208; *C. A.* 4, 2203.

An apparatus is described for the washing of bagasse fibers after they have been subjected to a mild alkaline solution.

154. IMPERIAL INSTITUTE. New materials for the manufacture of artificial silk. *Bull. Imp. Inst.* 27, 1–9 (1929).—*T. S.* 90, 287; *C. A.* 23, 3085.

Bagasse from Trinidad in the form of fibrous chips and crushed cane in pieces of irregular size up to 5 inches in length contained 10.8% water, 1.2% ash, and 51.2% cellulose (57.4% on dry basis). The fiber length was 0.6 to 5 mm. (average 1.95) and the diameter was 0.0152 to 0.0508 (average 0.0264). Cooking 3 hours at 140° C. with 20% caustic soda at a concentration of 3% yielded 48% of unbleached pulp which furnished a pale grayish-brown paper of excellent strength, containing a number of noticeable fibrous specks, probably derived from the nodes of the cane. With a light bleaching treatment, the yield was reduced to 40% (on the original material) of pulp which furnished a very pale cream paper of similar characteristics as the unbleached paper; the small specks were only partially affected by the bleaching treatment. The paper in both cases exhibited the "rattly" character of paper produced from fibrous material containing pithy matter. By mechanical separation of the pith from the fibrous material, it would no doubt be possible to produce paper of very good quality. Cooking as above after removal of 33% of pithy material by mechanical treatment yielded approximately 29% (43.5% on the mechanically treated material) of pulp containing 0.22% ash and 17.7% of alphacellulose. Pulp of satisfactory quality for rayon

manufacture was obtained by first freeing the air-dried bagasse as far as possible from pith by rubbing and sieving and then treating the material to a preliminary process of fractional digestion as follows: (*a*) boiled with water with continuous agitation and then filtered through a coarse sieve, after which the operation was repeated; this removed starches, sugars, soluble gums and other water-soluble matter, together with some finely-divided pith; (*b*) boiled with 1% caustic soda; the pithy matter attached to the fibers swelled and could be fairly readily separated by agitation; this operation was repeated and removed resins, fats, waxes, etc.; (*c*) a further washing in water was given and the material finally freed from almost the whole of the remainder of the pith by a light beating in the hollander. Cooking under the previously stated conditions yielded 68% of dry bleached pulp on the dry prepared material (approximately 26% of the dry original bagasse) which gave the following analysis: water 7.7%, into paper and board. The waste is sun dried in the sugar cane ash 0.14%, alpha-cellulose 86.1%, beta-cellulose 12.6%, gamma-cellulose 1.3%, copper number 0.56, phloroglucinol absorption 1.2%, soda absorption value 215, acetone extract 0.26%.

155. In Peru, sugar cane evolves into paper. *Business Week* No. 1132, 164–6 (1951).—*B. I. P. C.* 21, 763.

Brief reference is made to a process developed by W. R. Grace & Co., Peruvian sugar refiners, for converting bagasse fields, then shipped to the paper mill at Paramonga, which turns out 16,500 tons of various papers and boards yearly; last summer even newsprint was made from bagasse to prevent some of Peru's leading newspapers from closing. A factory at Lima converts the products to bags and boxes.

156. Irvine, F. A. Process of manufacturing hard board. U. S. patent 2,044,213 (June 16, 1936).—*T. S.* 103, 396; *C. A.* 30, 5335.

Hard board is a hard, dense, homogeneous product made from cellulosic fibers, generally by a process whereby the fibers, while wet, are heated and highly compressed until dried. This patent covers the production of such a board from bagasse, etc. The bagasse may be digested with water only for 2–3 hours at 45–50 pounds pressure or with about 8% of lime for about 2 hours at about 40 pounds pressure. The fiber is hydrated or mechanically refined in a beater, Jordan, Claflin, Bauer or like or equivalent refiner. During the refining, tung or other oil, in an amount of 1–5% is added; this is almost quantitatively adsorbed by the fiber, principally as an exterior coating or film thereon. The fibers are then formed into a sheet on a screen and subjected to pressure in a heated press—e. g., at a temperature of 325° F. and a pressure of 200–225 pounds per square inch. To develop the strength of the product and provide a waterproof surface, the product is further heated at about 200° F. for 6 to 24 hours.

157. Joachim, Herman L. Bleaching pulp. U. S. patent 2,186,487 (Jan. 9, 1940).—*C. A.* 34, 3493.

The unbleached bagasse pulp had an initial alpha-cellulose content of 86% and a copper number of 1. It was chlorinated at 3–3.5% consistency by the addition of 65% of its total chlorine demand at room temperature (not above 80° F.) for 20–30 minutes. After washing, the pulp at a consistency of 5–6% was treated with 2.5% (on the dry weight of the pulp) of sodium hydroxide at 120–124° F. for 45 to 60 minutes, and again washed. The pulp was then thickened to a consistency of 8–16% and treated with sodium (or calcium) hypochlorite equivalent to 25% of the chlorine demand for about 45 minutes, after which it was again washed. Finally, the pulp (at a consistency of about 4%) was treated with a strong caustic solution (1.64 parts of caustic for each part of pulp on a dry basis) for 2 hours at about 204° F. This gave a pulp with 96% alpha-cellulose. For 98% alpha-cellulose, the strength of the caustic was about 1.8 parts. The viscosity of the pulp was adjusted by acid treatment at about room temperature for 20–30 minutes, a consistency of about 4% being used. When 7 liters of 36% hydrochloric acid were used with 200 pounds of pulp, the viscosity was 25 to 38 centipoises in a 1% solution. To remove the grayish cast produced by the strong caustic, a final hypochlorite bleach is applied.

158. Joachim, Herman L. Alpha-cellulose pulp. U. S. patent 2,295,215 (Sept. 8, 1942) —*C A.* 37, 1268.

A method is proposed for the manufacture of a pulp containing 90% alpha-cellulose from bagasse. The initial chlorination is carried out with 75% of the total chlorine demand; after washing, the product is treated with caustic (1.5

parts per part of pulp) for about 1 hour at 175° F.; the final bleaching is carried out with sodium hypochlorite at room temperature. The viscosity of the pulp is adjusted by an acid treatment.

159. KARNIK, M. G. and SEN, D. L. Some promising cellulose-bearing materials (other than cotton) for the manufacture of rayon. *J. Sci. Ind. Research* (India) 7, 351–6 (1948).—*C. A.* 43, 2768.

Among the materials studied was bagasse, which was pulped with 15% sodium hydroxide for two hours at 20 pounds. The pulp yield was 33%. Viscose was prepared from the pulps prepared from the reeds and bagasse; these take up 85 and 64% of their weight of carbon disulfide (sulfite pulp takes up 80%). The viscosity of the viscose is 6.1, 28.0, and 30.4, respectively.

160. KASSER, A., and ROSSIGNOLI, P. Pulp production from annual plants by the neutral sulfite process. *Papeterie* 70, 279–85, 308–11, 313–14, 346–7, 349–51 (1948).—*C. A.* 43, 1183; *B. I. P. C.* 19, 356.

The chemical composition and fiber dimensions of various annual plants are discussed briefly, as well as various pulping agents. In spite of the higher cost of chemicals, the neutral sulfite process appears to be the most feasible economically, especially for small French mills with daily production of 5 to 20 tons. Two diagrams show the sequence (in a 10 to 12 ton mill) with the neutral sulfite process to produce bleached and unbleached bagasse pulp, from the initial cleaning of the fiber through the final bleach and washing stages. All operations are described quite fully and attention is given to accessory installations, water and power consumption, floor space, and labor requirements.

161. KATO, HARUJI. The studies on the utilization of bagasse. I. Drying of bagasse board. *Cellulose Ind.* (*Tokyo*) 10, 177–82; *Abstracts* (in English) 40 (1934).—*C. A.* 29, 632.

Bagasse board, as discharged from the machine, contains about 70% of free moisture. This is dried to a moisture content of about 10%. Conditions of drying are affected by the humidity of the air, the drying temperature, the method of drying, etc. An equation is given, which considers the adiabatic counterflow of air.

162. KATO, HARUJI. Utilization of bagasse. II. The drying of bagasse board. *Cellulose Ind.* (Tokyo) 10, 289–93; *Abstracts* (in English) 56 (1935).—*C. A.* 29, 3190.

Two new equations of drying are proposed, one for adiabatic parallel flow, the other for an isothermal counterflow.

163. KATO, H. Utilization of bagasse. III. Physical properties of Celotex. 1. Thermal conductivity. *Cellulose Ind.* (Tokyo) 10, 312–12; *Abstracts* (in English) 57 (1934).—*B. I. P. C.* 5, 142.

The thermal conductivity of Celotex was found to be much lower than that of wood, which indicates the suitability of this material for heat insulating purposes.

164. KATO, HARUJI. Utilization of bagasse. IV. Physical properties of Celotex. 2. Tensile strength, bending strength and hardness. *Cellulose Ind.* (Tokyo) 11, 74–9; *Abstracts* (in English) 10 (1935).—*C. A.* 29, 5623.

The tensile strength of bagasse board is 16.13 kg./sq. cm., the bending strength is 53.54 kg./sq. cm., and the hardness varies from 58.9 to 102.8.

165. KATO, HARUJI. Utilization of bagasse. V. Physical properties of Celotex. 3. Surface color and its change. *Cellulose Ind.* (Tokyo) 11, 155–62 (1935).—*C. A.* 29, 8276.

Because Celotex is used as a building material, the color changes on exposure to the atmosphere were examined. The original deep olive buff or drab gray color is changed into pale smoke gray on prolonged exposure.

166. KATO, H. Utilization of bagasse. VI. Physical properties of Celotex. 4. Ignition point. *Cellulose Ind.* (Tokyo) 12, 76–8 (1936).—*C. A.* 30, 7902.

The ignition point of four samples ranged from 203° to 222° C.

167. KATO, HARUJI. Utilization of bagasse. VII. Some measurement of thermal influences in a Celotex room. *Cellulose Ind.* (Tokyo) 12, 100–8; *Abstracts* (in English) 23 (1936).—*C. A.* 32, 3510.

Climatic conditions, such as temperature, humidity, and vapor pressure on a clear and a cloudy day, were observed both inside and outside a room whose walls were made from Celotex. On a hot day, the inside temperature lagged about one hour from that on the outside; on a cold, cloudy day, the inside temperature was a few degrees higher than the outside. The variations in humidity and vapor pressure were much smaller inside than outside. Thus, Celotex appears to be very effective for the regulation of the conditions inside a house.

168. KATZEN, RAPHAEL, PEARLSTEIN, JOSEPH, MULLER, ROBERT E., and OTHMER, DONALD F. A new method for the separation of lignin and cellulose. *Tappi* 33, 67–72 (1950).—*C. A.* 44, 4248.

The raw material is treated with chlorine in methyl alcohol at 66°. The crude cellulose is separated by filtration and methoxylignin chloride is isolated from the solution by an undisclosed process. The yield of these two compounds from bagasse was 68.4 and 16.5%, respectively. The process is covered by U. S. patent 2,491,499 (Dec. 20, 1941) issued to Katzen and Pearlstein [bagasse is not mentioned in the patent].

169. KAWAMURA, J. Cellulose production with the aid of chlorine. I. Bagasse. *J. Soc. Chem. Ind. Japan* 33, 392–5B (1930).—*T. S.* 93, 169; *C. A.* 25, 2562.

Airdry bagasse contains moisture 12.55, benzene extract 0.94, alcohol extract 1.99, aqueous extract 2.84, hot 1% sodium hydroxide extract 29%. The sodium hydroxide-extracted residue contains ash 3.5, lignin 22.3, cellulose (Cross and Bevan) 43.4, and pentosans, 27.4%. The cellulose contains 69.9% alphacellulose and 9.3% pentosans. After extraction with 0.5, 1, and 2% sodium hydroxide, bagasse was chlorinated at about 50% consistency, the change in yield, lignin, pentosans, and ash being followed. The more drastic the alkaline pretreatment, the lower were the yield and lignin content for an equal chlorine consumption. The pentosan content remained fairly constant at 31–33% of the chlorinated material. Of the pentosans, about 50% were removed by treating for 12 hours with cold 10% sodium hydroxide; 7% of the cellulose is simultaneously removed.

170. KAWAMURA, J. Pulping with chlorine. III. Reaction of chlorine. 2. *J. Soc. Chem. Ind. Japan* 34, 62–4B (1931).—*T. S.* 93, 169; *C. A.* 25, 2563.

Results similar to those reported for bamboo (J. Soc. Chem. Ind. Japan 33, 396–8B (1930)) were obtained with bagasse. When a large excess of chlorine was allowed to act on the bagasse for a long time, the ratio of hydrochloric acid to organic chlorides was slightly increased, indicating an oxidation.

(The abstract of the article on bamboo reads as follows: The ratio of chlorine as hydrochloric acid to organically combined chlorine formed in chlorinating lignocellulose has been reported as from 1:1.3 to 1:0.4. The author extracted bamboo with benzene-alcohol and 1% sodium hydroxide, chlorinated the residue, washed and extracted the product three times with 1% sodium hydroxide. Hydrochloric acid was determined in the wash water, after expelling free chlorine, and organically combined chlorine was determined by heating the sodium hydroxide extract at 250° C. and determining as sodium chloride. The ratio of acid to organically combined chlorine was 1:0.4).

171. KNEWSTUBB, J. J. Other fibrous raw materials. *Proceedings, Tech. Assoc., Australian Pulp & Paper Ind.* 1, 39–45 (1947).

The sugar industry of Queensland has in bagasse a raw material of potential value to the papermaking industry; 100,000 tons (oven-dry basis) might be available for papermaking. Although it is claimed that pulp of high α-cellulose content, as well as pulp suitable for general papermaking, may be prepared from bagasse, this raw material lends itself more readily to the production of boards. For papers, bagasse would be in competition with hardwood pulps, as the fiber length of bagasse pulps (1.2 mm.) is such that it would be classed as a short-fibered material. The bulky nature of bagasse, its high moisture content, poor baling qualities, and the distance from the center of board manufacture are factors which contribute to an uncompetitive cost for this raw material. However, should the papermaking industry be established in the northern areas, bagasse would probably be an important raw material. The well-known insulating board, Caneite, is manufactured from bagasse.

172. KODAMA, S. Paper pulp. Japanese patent 101,507 (June 14, 1933).—*T. S.* 99, 242; *C. A.* 28, 5239.

Bagasse, bamboo, or wood is treated with a bleaching powder solution in a ball mill.

173. KÜHNE, O. Can valuable pulp be made from bagasse? *Zellstoff u. Papier* 17, 526–31 (1937).—*T. S.* 107, 65; *C. A.* 32, 1091.

Analyses are given of bagasse and of bagasse given a moderate and a complete treatment according to the Ritter (No. 252) method; the results were: water, 9.9, 10.2, 11.0%; cellulose, 44.9, 56.2, 69.1%; lignin, 23.2, 21.1, 15.1%; sugar and waxes, 3.1, 0.25, 0%; ash, 2.45, 1.45, 1.03%; pectin (pentosans), 16.4, 10.9, 3.8%. The pretreated bagasse was pulped with sodium hydroxide and with sodium hydroxide plus sodium sulfite in laboratory and semicommercial-size digesters and the pulps were made into paper on an experimental paper machine. Pulp yields of about 70% were obtained with alkali consumption of 14–16% (on the basis of the bagasse). About 6% of chlorine was required to bleach the pulp to a good white. The pulp obtained with the sodium hydroxide-sodium sulfite (1:4) mixture bleached more easily than that prepared with sodium hydroxide alone, and the pulps were stronger than the soda pulps. On the basis of the high yields of pulp obtained from the pretreated bagasse, it seems that it could compete with wood in the manufacture of paper.

174. KUMAGAWA, H., *and* SHIMOMURA, K. Chemical composition and digestibility of bagasse and rice straw. *Z. angew. Chem.* 36, 414–8 (1923); *Papier-Fabr.* 22, 13–7, 21–3 (1924); *Paper* 32, no. 2, 7–10 (1923).—*T. S.* 77, 86, 187, 236; *C. A.* 17, 3419.

Analyses of raw bagasse, bagasse fiber, and bagasse pith gave the following values: water, 8.3, 8.1, 8.3%; ash, 2.4, 1.3, 3.0%; silica, 2.0, 0.46, 2.42%; fats and waxes, 3.45, 2.25, 3.55%; lignin, 20.0, 19.2, 20.1%; pentosans, 24.5, 26.1, 26.3%; cellulose, 46.0, 56.6, 49.1%; cellulose (pentosan-free), 34.5, 42.9, 36.8%. Bagasse contains 25–30% of short, pithy fibers, about 55–65% of long fibers, and 10–15% of water-soluble constituents. The short and long fibers can be separated easily when the bagasse is in a dry condition by passing the ground material through a screen; the chemical composition of the two fibers is about the same. Apparently excellent reduction of the raw material was attained by the use of liquors containing 3–3.5% total sulfur dioxide (40% of this as combined sulfur dioxide) at 135° C. for 11 to 13 hours. However, the resulting pulp was difficult to bleach, requiring about 30% of bleach on the weight of the fiber. This led to the conclusions that the decomposition of the raw material was incomplete and that the acid process was not suitable for bagasse. The use of a liquor containing both calcium and magnesium gave an easier bleaching pulp than with calcium bisulfite alone. This method might be suitable for the production of yellowish papers. The sulfite pulps contained about 76% cellulose, 15.7% pentosans, 0.9% ash, and 7.5% water. Sulfate digestion was carried out with a liquor containing 80 parts of sodium hydroxide and 20 parts of sodium sulfide; at 145° C. the digestion was complete in 4–8 hours. When the proportion of chemicals was 15% of the weight of the fiber, a pulp was obtained in 8 hours which bleached to a yellowish white with 21% of chloride of lime. With 20% chemicals, 15% of bleach was required; with 27% chemicals for 4 hours, the pulp bleached to a white with 9% of chloride of lime. The pulp yields were 55 to 60%. This pulp contained 66.7% cellulose, 25.1% pentosans, 1.4% ash, and 6.8% water. The use of the chlorine process gave about 45% of a pulp containing 64.1% cellulose, 28.4% pentosans, 0.5% ash, and 7% water.

175. KUMAGAWA, H., and SHIMOMURA, K. Papermaking fiber from material such as sugar-cane bagasse. U. S. patent 1,818,897 (Aug. 11, 1931); British patent 299,740 (1928).—*T. S.* 94, 138; *C. A.* 25, 5561.

A method of separating and recovering the long thin fiber and the short pithy fiber from bagasse and the like consists in subjecting the beaten material to the action of a body of water flowing in one direction to remove the sugar and other water-soluble material, in which the long thin fibers remain suspended in the water and the short pithy fibers float on the surface of the water.

176. KURAZAWA, HUMIO. Utilization of bagasse. I. Manufacture of bagasse pulp by the soda process. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 10, 215–24 (1938).—*C. A.* 33, 8010.

Heating bagasse with 5% sodium hydroxide at 145° for 1 hour gave pulp of good quality, containing 88.1% alpha-cellulose, 0.19% ash, 0.17% lignin, and 16.6% pentosans. The copper value was 0.68. The yield was 42%. The length and width of the fibers were, respectively, 0.83–0.90 mm. and 21.3–22.3 microns.

177. LAMARRE, LOUIS B. DE. Paper from bagasse. *J. fabr. sucre* 50, 31 (1909); *cf. Paper Making* 28, no. 1, 19 (1909).—*Auszüge* 1909, no. 1, 12.

This is a reference to a paper mill in Trinidad, which uses 65% bagasse, 20% bamboo, and 15% Para grass for the manufacture of a pulp.

178. LAMARRE, LOUIS B. DE. Treatment of megasse and other vegetable fibers. British patent 28,163 (Dec. 24, 1908).—*J. Soc. Chem. Ind.* 29, 147; *C. A.* 4, 2219.

Bagasse and other vegetable fibers are soaked in water and allowed to ferment spontaneously. After the fermentation has started, 2% of sodium hydroxide is added to assist the process. The mass is then washed with water, treated with sulfurous acid, and boiled in a rotary boiler with a solution of 12–25% of sodium hydroxide and 2% of potassium hydroxide (calculated on the weight of the dry material) under a pressure of 20–100 pounds per square inch. The material is then washed and converted into paper in the usual manner.

179. LANCELLA, PABLO. Cuba and chemurgy. *Chemurgic Digest* 3, 284–7 (1944).—*B. I. P. C.* 15, 83.

Most of the article is devoted to the manufacture of sugar and alcohol in Cuba. Mention is made of a plant producing wallboard from bagasse by the Vazcane process, with sugar as a by-product. Two pilot plants are working on the production of alpha-cellulose. Three tons of bagasse will yield one ton of a very pure pulp with an alpha-cellulose content of about 95%. The present research on the production of plastics from bagasse has not been successful, although a company in Louisiana is producing such a product. Work is in progress at the University of Havana on the preparation of a decolorizing char from bagasse to be used in sugar refineries.

180. LANDT, GUSTAV, and BECHER, HUBERT L. Pulp board. U. S. patent 1,860,466 (May 31, 1932).—*T. S.* 95, 224.

A board made of bagasse, straw, or other suitable material is provided with a binder of montan wax; from 30–50 parts of the wax may be used with 100 parts of fibers.

181. LATHROP, ELBERT C. Bagasse. *Tech. Assoc. Papers* 27, 64 (1944).

The Celotex Corporation uses about 30% of the bagasse produced by the sugar mills. It is necessary to bale the bagasse during the grinding season. The baled product is stored on the sugar mill property. The cost of the bagasse is about 50 cents a dry ton over and above the cost of the fuel. Other costs would involve baling, handling, and preserving. For the ordinary paper mill the most difficult problem would be one of freight. Mention is made of the sugar mill at Clewiston, Florida, with a grinding capacity of 4,000 tons [presumably per month] and a grinding season of 6 to 8 months. The author believes that bagasse would make a satisfactory corrugating board. Straw, cornstalks, and bagasse are suitable fibers for corrugating because of their high pentosan content.

182. LATHROP, ELBERT C. The Celotex and sugar cane industries. Bagasse or sugar a by-product? *Ind. Eng. Chem.* 22, 449–60 (1930); *Wochbl. Papierfabr.* 61, 1252–7 (1930); *Zellstoff u. Papier* 11, 28–9 (1931); *Papeterie* 53, 153–4 (1931).—*T. S.* 92, 146; *C. A.* 24, 6006.

This is a comprehensive article on the history of the Celotex development. It includes such topics as baling, storage, transportation, preservation; manufacturing process (cooking, washing, waterproofing, refining fiber, process control, drying, seasoning and sawing, inspection, fabrication); Acousti-Celotex; by-products (pith for explosives, dust for molding flours in the plastics industry); properties of Celotex; uses of Celotex (physical, thermal conductivity, sound absorption); market for insulation products; future economic factors; introduction of P. O. J. canes; the Florida project; other bagasse projects.

183. LATHROP, ELBERT C. Celotex, its manufacture and uses. *Trans. Am. Inst. Chem. Eng.* 25, 143–55; discussion, 169–72 (1930).

This article discusses the manufacturing process, the properties, and the uses of Celotex. The information is practically the same as that in the article in Industrial and Engineering Chemistry (No. 182).

184. LATHROP, E. C. The industrial utilization of sugarcane bagasse. *Sugar J.* 10, no. 6, 5–7, 19–30 (1947).—*B. I. P. C.* 19, 75.

Normally, about 20,000,000 tons of bagasse are produced annually in the manufacture of cane sugar, only slightly more than 500,000 tons of which are used. The annual production in the United States and its possessions amounts to 3,000,000 tons. Agricultural residues are a cellulose reserve practically untouched and unexplored. Their industrial utilization depends on their procurement on a sound economic basis, a determination of uses based on their superior or unique properties, the elimination of waste products to the greatest extent, the exploration of markets, the perfection of merchandising plans, and the arrangement for proper financing before any investment is made in plant facilities. The author discusses the utilization of bagasse in building materials, plastics, mulch, and litter, and of the pith as a filler in low-density, permissible-dynamite explosives. Potentially successful uses for bagasse are suggested as in papermaking, nine-point corrugated board, mulch paper, fine and specialty papers, chemical dissolving pulps, and industrial chemicals such as furfural, pentose sugars, and synthetic liquid fuels. Data are tabulated on the physical and chemical composition of varieties of sugarcane and bagasse, the chemical composition of some American woods, and fiber dimensions of some papermaking materials.

185. LATHROP, ELBERT C. The utilization of bagasse in the manufacture of Celotex. *J. Chem. Education* 7, 2391–2 (1930).—*C. A.* 24, 5895.

A short, somewhat popular account is given of the manufacture of Celotex. Much more detail is given in the two preceding articles.

185a. LATHROP, E. C., ARONOVSKY, S. I., and NAFFZIGER, T. R. Increased profits from cane sugar byproducts. *Sugar J.* 14, no. 1, 10, 12, 14, 25–32 (June, 1951).

The fiber and pith of bagasse are separated by treatment for about 30 minutes in cold water in a Hydrapulper; the dirt is removed by screening and the pith and fiber are fractionated. The dirt content of commercial samples varied from 11 to 17%; the ratio of pith to fiber varied in different samples from 1:2 to 1:4. Screen fractionation of the fibers showed that the Louisiana samples contained 75 to 84% of fibers more than 0.75 inch long; a Florida sample contained 28.7%. Data are given for the proximate analysis of these three samples. Bagasse can be treated with lime or caustic soda to give 70% of pulp suitable for 9 point board (the lime-cooked pulps tend to give lower crush resistance values). Another method is the use of the Hydrapulper [8% sodium hydroxide (on bonedry bagasse) at 9% consistency for 0.75 to 1.25 hours at 210° F.]. Satisfactory pulp can be prepared from either stored or fresh whole bagasse. The Florida pith-free bagasse pulp might be mixed with southern pine kraft pulp for liner board. Bagasse (either fresh or stored) was also cooked with 12% kraft chemical (33% sulfidity) for 2 hours at 338° F. (100 p. s. i.) or by the neutral sulfite semichemical process. The yields of screened pulp from the whole bagasse were slightly lower than that from wheat straw by the mechanochemical process; the bursting strength and folding endurance were lower. Pith-free bagasse gave yields above that from straw and the bursting strength and folding endurance were higher than those for pulps from whole bagasse. The Florida pith-free pulp is distinctly superior in strength to any of the hardwood pulps. It appears that fine bleached papers could be produced from depithed bagasse. On the basis of southern pine at $16.00 (2400-pound cord), bagasse would have a value of $18.65 per ton (f. o. b. paper mill). The pith may be used as a fuel or as an absorbent for blackstrap molasses; for the latter purpose it would be worth $29.80 per dry ton if corn is valued at $1.50 a bushel. Calculations indicate that an additional income to a sugar mill of $1.09 to $1.68 per ton of cane ground, depending on whether oil or gas replaces bagasse as a fuel.

186. LATHROP, ELBERT C., and IRVINE, FERGUS A. Fiber product preservation. U. S. patent 1,880,965 (Oct. 4, 1932).—*T. S.* 97, 260.

The patent (presumably relating to Celotex made from bagasse) provided for the incorporation of an arsenic complex into the fibrous material. Compounds of antimony and bismuth may be used in place of arsenic. Various methods are

proposed for the preparation of the slurry of these compounds. In one, a solution of 9 grams of arsenic trioxide and 5.4 grams of sodium hydroxide in water is added to a solution of 15 grams of alum in water, forming a thick, gelatinous, substantially insoluble precipitate of a complex alum arsenical. In another, 1.2 parts of arsenic trioxide, 1.4 parts of sodium hydroxide, and 2 parts of ferric chloride are used. A calcium arsenite is also mentioned and its preparation illustrated. The amount of the arsenical used with the fibers is not stated.

187. Lathrop, Elbert C., and Irvine, Fergus A. Process of making panel board. U. S. patent 1,881,418 (Oct. 4, 1932).—*T. S.* 97, 259.

In the manufacture of a hard panel board from bagasse or like vegetable material, the raw material is initially prepared in the presence of an alkali and buffer salt, a pH range of 7 to 10 or even 11 being suggested, with the preferable pH being 8.2. If the fibrous material is separated by the explosion process, sufficient alkali should be provided, as by soaking the material, to provide an initial alkalinity of pH 8.2. If the material is separated by a digestion and mechanical refining, the digestion should be initiated at a pH of about 8.2; even if the separation be by crushing, it is advantageous to use sufficient alkali in the liquid in which the material is soaked and worked to provide an alkalinity of pH 8.2 at the start of the mechanical operations. This is accomplished by the use of calcium and/or magnesium salts—e. g., the carbonates. A similar pH should be maintained during the sheeting operation.

188. Lathrop, Elbert C., and Irvine, Fergus A. Preserving fibrous materials such as insulating board. U. S. patent 1,935,196 (Nov. 14, 1933).—*T. S.* 99, 52.

Fibrous material may be preserved by incorporating therein a colloidal complex of ferric hydroxide and arsenious acid; the amount is equivalent to 1% of arsenious oxide (based on the dry weight of the fiber).

189. Lathrop, Elbert C., and Irvine, Fergus A. Process of utilizing fibrous materials. U. S. patent 1,973,637 (Sept. 11, 1934).—*T. S.* 100, 286.

The raw material (bagasse and the like) is lightly digested with an alkali (such as calcium oxide, sodium hydroxide, and the like) and is then preferably brushed out in a beater while hot and in the presence of alkali, or is hot shredded or the like; this causes a slight degree of hydration of the fiber bundles. As an alternative, the raw material may be soaked thoroughly in an alkaline solution and then crushed between rolls or it may be soaked in an alkaline solution and distintegrated by the explosive process. After washing, the material is ready for sheeting.

190. Lathrop, Elbert C., and Munroe, Treadway B. Industrial preservation of crop fibers. *Ind. Eng. Chem.* 26, 594–8 (1934).—*T. S.* 99, 238; *C. A.* 28, 4622.

The development of a commercial process for the preservation of bagasse during storage is described. The best method consists in so piling the bales that the heat of carbohydrate fermentation is used to raise the temperature of the interior bales to that corresponding to pasteurization. The insulating qualities of the mass maintain this temperature for 2 or 3 months. The moisture content of the mass is greatly lowered, so that the spores of organisms living through the heating stage will not germinate. The outside of the pile is protected from rains by a portable roof of steel panels and also by the use of boric acid (4 pounds per ton—2 pounds in the pile on the edges of the side bales and 2 pounds on the top bales). The chemical cost is 6.4 cents per ton of dry fiber. The average fiber loss per annum is less than 10%, being reduced more than 60%. The yearly cost of chemicals and roof is offset by savings in labor in removing the piles, because of the time saved in handling solid rather than broken bales. The dollar savings for the first year amounted to more than five times the entire development cost.

191. Lathrop, Elbert C., and Munroe, Treadway B. Preparing and preserving fibers for pulp-making purposes. U. S. patent 1,572,539 (Feb. 9, 1926).—*C. A.* 20, 1323.

Raw bagasse in piles is subjected to an alcoholic or acetic acid fermentation under such conditions that the temperature will rise to about 60° C. and the temperature is maintained for a sufficient time that the mass becomes substantially sterile; the material will remain in that state as long as moisture is prevented from entering the mass. The fibers of bagasse thus treated retain their strength unimpaired; they are softer than untreated fibers and they will not require as much cooking and refining in the process of making heat insulating boards as do untreated fibers.

192. Lathrop, Elbert C., and Munroe, Treadway B. Method of preserving fibers for pulp-making purposes. U. S. patent 1,572,540 (Feb. 9, 1926).

A process of preserving bagasse and analogous fibers from injurious fermentations during storage consists in wetting the fibers to approximately their water-holding capacity and keeping the mass sufficiently wet to prevent the growth of undesirable molds and fungi, while a fermentation of the lactic acid type proceeds throughout the mass. The lactic acid fermentation destroys the parenchymatous matter binding the bagasse fibers into bundles.

193. Lathrop, Elbert C., and Munroe, Treadway B. Retted bagasse fiber and process of producing same. U. S. patent 1,633,594 (June 28, 1927).

A process of retting bagasse fibers consists in subjecting such fibers to an alcoholic fermentation, causing the heat generated to sterilize the mass to a substantial extent, adjusting the moisture content in excess of 60%, and subjecting the mass to the fermenting action of a micro-organism of the mushroom type (Psilocybe).

194. Lathrop, E. C., and Naffziger, T. R. Evaluation of fibrous agricultural residues for structural building board products. I. Methods and equipment. *Paper Trade J.* 127, no. 27, 55–60 (1948); *Tech. Assoc. Papers* 31, 337–343 (1948).—*B. I. P. C.* 19, 118; *C. A.* 43, 1187.

Freeness determinations were made on a mixture of strawboard pulp (I), bagasse fibers greater than 0.5 inch in length (II), and bagasse fibers less than ¼ inch in length (III); the proportions are given in percent by weight.

I	II	III	Freeness
45	--	55	280
35	5	60	360
25	10	65	450
15	15	70	550
5	20	75	710

The following values are given for a commercial bagasse board 0.478 inch thick and having a density of 0.301 g./ml.

	Lengthwise	Crosswise
Flexual strength, p. s. i.	214	176
Tensile strength, p. s. i.	207	128
Impact strength, ft.-lb./sq. in.	1.00	1.28

195. Lauga, Charles. Improvement in separating and cleaning vegetable fibers for paper-pulp. U. S. patent 210,339 (Nov. 26, 1878).

The raw material is boiled in an alkaline saccharate solution for 2–10 hours, pressed between rolls, ground in a pulp mill, and made into paper.

196. Leao, F. G. P. Extraction of cellulose from vegetable products. British patent 293,219 (Aug. 15, 1927).—*T. S.* 90, 233.

Cellulose is prepared from bagasse and the like by soaking the crushed and disintegrated raw material for 4–9 days at about 32° C. in the unfermented sap extract from freshly cut, mature banana plants. The cellulose remaining after the removal of the spent liquor (which may be used as a fertilizer) is washed with cold dilute hydrochloric acid or sulfuric acid and then with water.

197. LeBourgeois, Edward C. Production of paper-pulp from sugar-cane or other fibrous vegetable substances. U. S. patent 278,977 (June 5, 1883).

The original sugar cane or the bagasse therefrom is subjected to a pressure of sufficient force to break up the cellular formation of the cane; the product is subjected to a boiling process, in a rotary digester, to disintegrate the fiber thoroughly; after sufficient boiling, a sufficient quantity of caustic is added to insure the liquefaction of matter foreign to the nature of the pulp—pitch, silica, resin, etc.—after which the product is washed thoroughly.

198. LEE, CHARLES T. Process of reducing fibrous material to pulp. U. S. patent 701,271 (May 27, 1902); British patent 7,774 (April 2, 1902).—*J. Soc. Chem. Ind.* 22, 646.

The raw material, permeated with moisture, is subjected to the action of gaseous chlorine, which may be done by immersing the loose mass of material in a receptable containing the gas for a period of 0.5 to 1 hour; the time depends to some extent upon the coarseness of the raw material. The treated material is washed with water and bleached with aqueous chlorine or an alkaline hypochlorite. It is stated that one half the chlorine unites with the water to form hydrochloric acid and the other half unites with the intercellular matter of the material to form a soluble chlorine compound. The process produces excellent pulp from bagasse.

199. LEE, CHARLES T. Process of treating sugar-cane. U. S. patent 1,155,741 (Oct 5, 1915); British patent 17,834 (July 28, 1914).—*C. A.* 9, 3358.

Moist bagasse is dried, preferably by agitation in a current of highly heated gases of combustion, to a moisture content of 15–25%, thus being in a condition so that those portions of the pith which still adhere to the fibrous strips may be, to a large degree, shaken free by impact or detached by a shredding or picking process. This may be achieved by the use of a Williams pulverizer or other impact device, followed by screening by a series of vibratory screens of varying mesh, or, in general, any device or series of devices capable of detaching the pith and separating the "selected" fiber. For example, the method may involve the use of air flotation. The rejected fractions are burned. The selected fiber is washed, usually by systematic diffusion, and is then digested for the preparation of paper stock. One method consists in digestion for about 8 hours under 40 pounds steam pressure, in the presence of caustic soda equivalent to about 14% by weight of dry fibers.

200. LEE, CHARLES T. Treatment of vegetable fiber for paper pulp. French patent 345,632 (Aug. 4, 1904).—*J. Soc. Chem. Ind.* 24, 40.

Vegetable matter, particularly crushed sugar cane bagasse, is boiled in an alkaline saccharine solution, such as a solution of calcium or magnesium sucrate. The time of boiling and the concentration of the solution are so regulated as to cause the minimum of damage to the delicate fibers. This is apparently the same as U. S. patent 713,116 (Nov 11, 1902), although the U. S. patent does not mention bagasse.

201. LEE CHARLES T., and MONKS, ALLAN B. Process of treating sugar cane U. S. patent 1,153,934 (Sept. 21, 1915).

For the purpose of removing the wax from bagasse, the material is treated with a "diluted cell liquor," the cathodic product from the electrolysis of solutions of brine in a diaphragm cell and containing caustic soda, sodium chloride, some sodium sulfate, and small amounts of sodium hypochlorite and chlorate. The bagasse is digested with this cell liquor for 10 to 14 hours under 10 to 30 pounds of steam. The recovered liquor may be used for the preliminary digestion of fresh batches of bagasse. The washed fiber is then subjected to a second cook for 4 to 6 hours under 40 pounds pressure. Details of the recovery of the wax are given.

202. LEHTINEN, W. Insulating board (Celotex, Masonite, etc.). *Finnish Paper and Timber J.* 11, no. 2, 74, 76–7 (1929).

203. LEVI, CAMILLO, and DEBENEDETTI, EMILIO. Cellulose from stems of Sorghum saccharatum. *Ind. carta* 5, 294–9 (1938).—*C. A.* 33, 4017.

Sorghum saccharatum bagasse, in a state of fermentation, was pulped with sodium hydroxide-sodium sulfite and the resulting pulp was bleached with 4% chlorine. The pulp yield (air-dry basis) in the semi-commercial operations was 33.2% and in the industrial scale operation was 41%. With a high degree of refining, the two pulps had a Schopper-Riegler freeness of about 50° and 60°, respectively. The following physical characteristics were determined for the two pulps: breaking length 6980 and 6820 meters; stretch 2.7 and 2.5%; double folds (tension 1000 grams) 136 and 29; bursting strength 4.1 and 3.7 kg./sq. cm.; tearing resistance, 42 and 39 grams. An extra-strong paper containing 80% of bleached sorghum pulp and 20% of bleached fir pulp, loaded with 10% talc and resin glue, was prepared in commercial scale experiments, which had the following physical characteristics, in and across machine direction, respectively: breaking load 5.11 and 2.88 kg.; breaking length 5850 and 3200 meters; stretch 1.4 and 2.8%;

double folds 12 and 6. The raw cellulose was improved by treatment with cold 5% nitric acid, mild alkali cooking, long treatment with cold 5% sodium hydroxide, and bleaching. The yield of purified pulp was about 25%; the pulp had the following characteristics: alpha-cellulose 92.5–93%; copper number (new Schwalbe-Hägglund method) 0.5; alcohol-benzene extractives 0.2%; viscosity (unified German method) 26.

204. Levi, Camillo, and Debenedetti, Emilio. The manufacture of pulp from bagasse. *Ind. carta* 5, 294–9 (1938).—*B. I. P. C.* 9, 95.

Semi-commercial experiments are described for the manufacture of pulp from bagasse by a suitable modified monosulfite process. The resulting pulp was superior to straw pulp with regard to strength properties and ease of bleaching, yielding approximately 40% of bleached pulp. Reference is made to pulp purification experiments on a laboratory scale and to experiments for preparing the raw material in such a manner as to reduce the exceedingly high transportation cost.

205. Levi, Camillo, and Debenedetti, Emilio. Use of bagasse as cellulosic raw material. *Ind. carta* 4, 171–7 (1937).—*T. S.* 106, 132; *B. I. P. C.* 7, 405.

Studies carried out at the Italian research station on the pulping of bagasse are reported. The sodium monosulfite and the chlorine gas methods were found suitable for this purpose. The yield of unbleached pulp was 40–45%. The fibers are longer than those from straw; the raw material, however, contains a large percentage of nonfibrous and useless pith. The most suitable pulp, from the papermaking point of view, was obtained when it was beaten to about 50° S.-R. It can be mixed with a furnish of longer fibers to give paper with less rattle. Studies are in progress for testing the suitability of the material for the manufacture of rayon and chemical derivatives.

206. Levy, N. Employment of bagasse in the manufacture of paper. *Bull. assoc. chim. sucr. dist.* 19, 215–7 (1901); *Expt. Sta. Rec.* 13, 597.

207. Lewis, Robert C. Factors governing the utilization of agricultural residues for paper and paper board. *Chemurgic Digest* 4, 272–8 (1945).

Reference is made to the Wells process [Cf. No. 423] for pulping and converting cornstalks and bagasse into bleached fine-fibered pulps and non- and short-fibered fractions available to impart stiffness to board products. From an analysis of the cost data for the various manufacturing operations, the following estimated costs are determined: sulfite pulp, $39.41; sulfate pulp, $36.59; cornstalk pulp, $35.49; bagasse pulp, $30.29. It is further estimated that the use of cornstalks and bagasse would add 5,258,000 tons of fibrous material to the annual supply of papermaking materials.

208. Lhuilier, R., and Maurice, L. Treatment and utilization of cellulosic materials and fibrous industrial wastes. French patent 405,684 (Aug. 3, 1909).—*J. Soc. Chem. Ind.* 29, 417.

The object of the invention is the conversion of fibrous wastes, particularly sugar cane bagasse, into pure bleached cellulose suitable for the manufacture of cellulose derivatives. The cellulosic material is preferably packed in iron baskets which can be immersed in boilers, lifted out, and transferred to other boilers without unloading. The chemical treatment consists of a digestion, at the boiling temperature or otherwise, in a solution of an alkali carbonate, followed by bleaching with an alkaline hypochlorite solution. The digestion with sodium carbonate is best effected with a battery of three boilers in order to obtain a systematic exhaustion of the liquors.

209. Lightfoot, Gerald. Paper pulp—possibilities of its manufacture in Australia. *Bull. Commonwealth of Australia, Adv. Council Sci. and Ind.* No. 11, 1919. 39 pp. Reprinted or abstracted in: *Paper* 24, 832–4, 929–32, 972–3, 1014–5, 1061–4, 1100–2, 1141 (1919); *Bull. Imp. Inst.* 17, 415–21 (1919).—*C. A.* 13, 1530.

In the discussion of megass or bagasse (*see Paper* 24, 1101), it is stated that megass obtained in the ordinary method of crushing in sugar mills is not very suitable (for papermaking) and that it is desirable to establish a special method for extracting the sugar. In view of this fact, and the facts that most of the megass produced in Queensland is used as fuel for the sugar mills, and that its value for fuel is greater than its probable value for pulping, there seems little prospect of the

commercial utilization of megass for pulping in Australia. In Queensland, assuming an annual cut of 3,000,000 tons of cane having a dry fiber content of 10%, there is a possibility of obtaining 300,000 tons of pulp per year.

210. LINVILLE, DONALD. Development and uses of structural insulation board. *Domestic Commerce* 35, no. 7, 23–9 (1947).—*B. I. P. C.* 17, 684.

Structural insulation board, developed to utilize waste from the paper industry and now one of the major industries in the building field, had a 1946 output of approximately 61 million dollars. With anticipated increases in production facilities, the annual output is estimated at over 2.2 billion sq. ft. Originally made from waste sulfite screenings, this material is now also manufactured from waste wood, bagasse, corn stalks, licorice roots, and wheat straw. The fibers are felted together to form a board with an average tensile strength of approximately 150 p.s.i. The insulation value lies in the small air spaces within the cellulose fibers forming the board. The heat transmission can be calculated from the density per cu. ft., thickness, and the materials of which it is made. The average thermal conductivity is 0.38. When sheathed with an asphalt-impregnated or asphalt-coated material, the product is more durable and moisture resistant. Uses and stock sizes are given.

211. LITKENHOUS, E. E. Bagasse utilization. WPB Project—134. 51 pp. and 47 unnumbered pages of bibliography. July 31, 1944. Processed. Abstract in *Chemurgic Digest* 4, 169, 171–8 (1945); 8, no. 6, 12–16 (1949); *Pulp Paper Ind.* 20, no. 3, 30, 32, 32b, 34, 70 (1946). *B. I. P. C.* 16, 379; 19, 754.

From a survey of the literature (the author lists about 850 references but many of these are duplicates and a large number refer to the utilization of cornstalks), the following indications are listed: (1) All the early work recognized the advantages to be gained by using bagasse as a source of paper and/or alpha-cellulose. (2) In this work, bagasse was handled similarly to wood; the drastic chemical treatment necessary to remove the pith completely affected the bagasse fibers, thereby making the product unsuitable for processing or too expensive to produce. In none of these cases was bagasse handled according to the physical properties which it presented. (3) In any installation where bagasse was cheaply handled to separate the pith and fiber (Godchaux or Celotex process), the utilization of bagasse has been economically feasible. (4) Specialty papers, fine papers, liners, corrugating paper, and boards can be produced to use approximately 55% of the bagasse (dry basis), leaving the remaining lignin, etc., for plastic and other developments. This method uses bagasse according to its peculiar properties and makes a cheap separation. (5) Cost figures indicate that bagasse can be obtained at a 100-ton-per-day pulping mill for $4.75 to $5.67 per ton of dry fiber and can be made into pulp ready for paper or board manufacture for from $16.65 to $18.15 per ton of pulp, as compared with southern slush kraft pulp at $21.19, Pacific Coast groundwood at $16.78, and cheap sulfite pulp at $36.00.

In general, a process using the following separations appears economically feasible: (1) Attrition (mechanical) shredding of bagasse (either wet or dry). (2) Hot water or air separation of soluble materials and pith, using screens, cyclones, centrifuging, or decantation methods. (3) Subsequent semichemical, chemical, and/or physical treatment to handle the separate fractions according to their individual properties. (4) The use of such pulp directly or blended with other pulps in standard paper-making equipment.

Bagasse has the following advantages over either wood or other vegetable wastes in that it (1) is concentrated at the sugar mill where sugar juices are removed, (2) is crushed and washed in the sugar extraction process, and (3) has a high annual production rate. The cost of dry bagasse per ton (excluding shrinkage and losses) is estimated at $4.75 to $5.00 at the mill; with 45% losses, the price would be $7.30 to $7.70 per ton of usable pulp material, as compared with $6.80 to $21.54 for wood. The production costs to convert the material into usable pulp are estimated at $8.65 per ton of dry bagasse pulp, whereas for wood they are from $7.86 to $29.84 per ton.

212. LITTLE, ARTHUR D. Bagasse. *World's Paper Trade Rev.* 59, 365–6 (1913); *Papier-Fabr.* 11, 339–40 (1913); *Papier-Ztg.* 38, 2515 (1913).

This is a letter from Little to John Christie on the Simmons process, in which there is a partial separation of the fiber and pith, so that the raw fiber gives a satisfactory yield and lends itself in quite a remarkable way to the requirements of the industry. It is very easy to hydrate the cell walls of the pith superficially,

so that, as they dry down in contact with each other, there is a coalescence of adjacent walls which determines the formation of the very hard final product. By simply grinding 70% of pith and mixing it with 30% of hydrated pith, the latter acts as an adhesive and gives a very light, strong product. If the material is all hydrated, the final product is much like hard rubber in its physical properties. Twenty per cent of hydrated pith added in the beating engine to other stock of the usual sorts gives great snap and rattle to the resulting paper. If the hydrated pith is run by itself on the paper machine, a kind of parchment paper is obtained.

213. Little, Arthur D., Inc. Papermaking qualities of Hawaiian bagasse. *Expt. Station, Hawaiian Sugar Planters' Association, Bull.* 46 (1919). 51 pp. *Paper Makers' Mo. J.* 59, 285, 287, 289, 291 (1921).—*J. Soc. Chem. Ind.* 38, 895A; *C. A.* 14, 121; 15, 2983.

The best yields of bleached pulp were obtained from the yellow Caledonia variety of cane. Both the plain caustic soda and the sulfate processes may be used, and the technical results from both processes show little difference. The yield of unbleached pulp from the Caledonia bagasse is about 30% on the air-dry bagasse without shredding. On the basis of the material shredded by the Simmons process, this would be equivalent to 48%. The quality of the pulp is excellent for fine white papers, especially when blended with longer fibers. The cost of bagasse at the mill may be taken at its fuel value, green bagasse containing 45% of moisture. The principal feature in the preparation of bagasse for pulping is the separation of the pith from the fiber by shredding, milling, and sifting in a rotary screen. This separation must be done before digestion to save the consumption of chemicals by the valueless pith cells. This problem has been satisfactorily solved in Cuba by the Simmons process. A difficulty in the utilization of bagasse is the storage of the material in the "off" season. Cane crushing extends over 8–9 months and the space required for storing sufficient material for the remainder of the year would be very large. The storage of the pulp would be far more economical.

214. Little, Arthur D., Inc. Samples of paper made from sugar-cane fiber, prepared by the Simmons process. 1913. 57 pp.

This book contains samples of paper made from bagasse by the Simmons process, in which the fiber and pith are separated. The fiber is cooked by the soda process; the yield of unbleached pulp is about 45% of the raw extracted Simmons fiber; the bleached yield is over 40%. The pith may be converted into a material of papermaking value, its function being to impart a parchment-like quality to the papers in which it is used. The following types of papers are included:

Simmons fiber: Bible, book, cover, envelope, folder, tissue, waterleaf, and wrapping; mixed with other pulps, book, newsprint and writing.
Simmons pith: Glassine, pergamyn, and waterleaf.

215. Loomis, Burdett. Process of making cellulose. U. S. patent 1,311,980 (Aug. 5, 1919).

The green plant, such as sugar-cane, etc., is pressed to remove the juice, shredded, and treated with warm water below the boiling point to remove the saccharine matter (8 to 12 hours at a temperature below 150° F.); during this period a fermentation process sets in, because of the development of bacteria that feed on the sugar and which will destroy the value of the fiber. At this stage, the liquor is withdrawn and fresh water added; if cellulose is desired, the temperature may be raised to 150° F. or above and finally to 212° F.; an alkali (sodium hydroxide or calcium hydroxide) may be added to complete the cooking operation. It is claimed that, by this process, the strength of the fiber is increased 50%.

216. Lopez de la Camara, M., and Egana, F. Robledano. Manufacture of paper, millboard, etc., from bagasse and other vegetable refuse. French patent 324,599 (Sept. 18, 1902); British patent 20,575 (Sept. 20, 1902).—*J. Soc. Chem. Ind.* 22, 569.

Sugar-cane bagasse, or the refuse from sorghum, maize, reeds, or vegetable matter, is submerged in a solution of caustic soda containing 10% of soda calculated on the raw material to be treated. The temperature at which the bagasse is introduced into the solution should be 60° C., at which temperature a vigorous reaction occurs. The material is treated for 45 to 60 minutes, according to the conditions. The mass is then removed and bleached, either with sulfurous acid or bleaching powder.

216a. LSU waste bagasse research is now six years underway. *The Daily Iberian* (New Iberia, La.), May 19, 1951.

A news item states that Paul M. Horton and Arthur Keller of Louisiana State University have been engaged in research on bagasse for six years and have constructed a pilot plant. The following conclusions have been reached: Good quality paper *can* be made from bagasse under pilot plant conditions. About 27% of the weight of the raw bagasse can be recovered as high grade fiber from which the paper is made. One ton of bagasse per hour can be produced in the present experimental mill. The following items need solution: storage quality of the fiber (methods of sterilizing and storing), power requirements, and production data. The kraft process is too drastic for the bagasse fiber; waste chemicals of lesser strength might be feasible.

217. LYNCH, D. F. J. Bagasse cellulose. *Repts. Assoc. Hawaiian Sugar Tech., 13th Meeting*, 1934, 159–61; *Facts About Sugar* 30, 11–12 (1935).—*T. S.* 101, 61; *C. A.* 29, 597.

Although dry bagasse contains about 55% cellulose, commercial attempts to produce paper from bagasse have not been successful thus far. The nitric acid process of pulping has been further improved through reuse of the acid and by the introduction of an alloy resistant to hot dilute acid. Further study may lead to the solution of the problem.

218. LYNCH, D. F. J. Cellulosic agricultural by-products. Possibilities for industrial utilization. *Ind. Eng. Chem.* 31, 149–53 (1939).

Brief mention is made of the work of the Agricultural By-Products Laboratory at Ames, Iowa, on the nitric acid pulping of bagasse. The work has reached a pilot-plant scale of 500 to 1000 pounds per run in Hawaii and the Philippine Islands. The work in Louisiana and Puerto Rico is not so far advanced. The pilot plant at Ames has a reaction tank with a capacity of 500 gallons. At present work is concentrated on the efficient utilization of the pulping solution. Some of the experimental and economic difficulties involved in the utilization of such materials for papermaking are discussed.

219. LYNCH, D. F. J., and GOSS, M. J. Bagasse cellulose. *Ind. Eng. Chem.* 24, 1249–54 (1932).—*T. S.* 95, 307; *C. A.* 27, 595.

The composition of bagasse was found to be: cellulose, 53.7–57%; lignin, 2.35–2.7%; pentosans, 21.4–23.5%; fat and wax, 2.35–2.7%; ash, 4.3–6.0%. Other analyses in the literature are given. A series of 48 experiments was carried out, using the soda process, the sulfate process, and the neutral sulfite process; the yields of pulp varied from 33 to 49%. With an amount of sodium hydroxide equal to 25% of the charge, a liquor ratio of 5:1, and a 6-hour cook at 125 pounds per square inch, a yield of 34–35% of good bleachable pulp can be obtained. These were the optimum conditions as determined by cooks in which the sodium hydroxide was varied from 15 to 35%. With 2 parts of sodium hydroxide to 1 of sodium sulfide, an active alkali percentage of 25%, and a liquor ratio of 5:1, a 6-hour sulfate cook at 100 pounds per square inch gave a yield 1 to 1.5% higher than the soda process. With the Keebra or sodium sulfite method, yields of 37.5% of good, easy-bleaching pulp can be obtained readily under the best conditions. However, sodium sulfite is not a very effective pulping agent, even at high pressures, in concentrations lower than 20%. The possibility of removing the pith was investigated. The long fibers of bagasse were about 5 mm. in length and the short fibers were 0.5 mm., with an average length of 1.9 mm. The diameter of the fibers ranges from 0.016 to 0.050 with an average of 0.026. Because it was felt that larger percentages of the cellulose present in bagasse should be recovered, the nitric acid process was investigated. The optimum conditions were the use of 5% nitric acid for 1 hour at 80° C. After thorough washing, the material was boiled for 30–45 minutes with 2% sodium hydroxide. The yield (42–46%, unbleached) average 4% higher than that of the Keebra process under optimum conditions. The yield of bleached pulp was 38–40%; this contained 86–93% alpha-cellulose and 9.4–11% of pentosans, with 16–31% of soda-soluble material; treatment with 9% sodium hydroxide at 100° C. decreased the soda-soluble content to 5.3–11.5% and the pentosans to 2.4–3.1%; the alpha-cellulose was increased to 93–97.4%. The disadvantage of the method is that tanks resistant to nitric acid must be employed. It is calculated that the cost of the nitric acid would be 2.5 cents per pound and that the cost of unrecovered nitric acid would be about $11.50 per ton of alpha-cellulose. The recovered nitric acid (about 70–75%) can be reused.

220. McEwen, R. L., Sheldon, F. R., and Nelson, D. H. Hydrogen peroxide bleaching of chemical and mechanical pulps. New developments and process applications. *Tappi* 34, 193–201 (1951).

Bagasse pulps, prepared by the neutral sulfite semichemical method and by the kraft process, can be bleached with hydrogen peroxide. The value of a hypochlorous acid pretreatment is unquestionable, as is the use of moderate or high densities. The following results were obtained.

Pulping method	HOCl pretreatment av. chlorine %	H_2O_2 (50%), %	Unbleached	Hunter brightness, % pretreated only	H_2O_2 bleached
Neutral sulfite	1.0	2.0	48.0	58.7	71.2
		2.0	48.0		59.3
Kraft	3.0	2.0	33.8	42.5	65.1
		2.0			48.0

221. McKee, Ralph H. Hydrotropic process for paper pulp from bagasse. 1946. 45 p. Typewritten.

The pulping agent is a strong solution of the sodium salt of certain organic acids, such as benzenesulfonic acid, xylenesulfonic acid, cymenesulfonic acid, and the like. Of these sodium xylenesulfonate is the cheapest and operates the best. The same solution can be used for six or seven cooks before the acid is recovered. Actual details of the process are not given but some indication of the type of equipment to be used and a flow sheet of the process are included.

222. McKee, Ralph H. Use of hydrotropic solutions in industry. *Ind. Eng. Chem.* 38, 382–4 (1946).—*B. I. P. C.* 17, 283.

Hydrotropic solutions are better solvents than is commonly appreciated for slightly water-soluble inorganic or organic solutes. They offer a new basis for organic electrochemical reactions, and other reactions of strictly chemical character proceed better than when ordinary solvents are used. The new hydrotropic process for paper pulp manufacture, using a neutral sodium xylenesulfonate solution, gives excellent results and is less expensive than the customary alkaline processes. There is little or no degradation of the cellulose, and a high yield, as well as a high α-cellulose content, of the pulp is obtained. The lignin is also recoverable in a form essentially unchanged from that in which it was present in the cellulosic material (wood or bagasse) used. When the cooking is carried out with a neutral solution of 30 to 40% sodium xylenesulfonate, the same solution can be used for six or seven cooks before being reworked or recovered for re-use. The limit is reached when saturation with lignin is approached (about 350 grams per liter of solution). The hydrotropic pulp process used on poplar wood gave a yield of 52% cellulose (as compared with 47% by the sulfite and 45% by the soda process); the yield of unbleached bagasse pulp is about 48%; bleaching reduces it to 42%. This is a lower yield of bleached pulp than is now obtained by chemical processes from wood, but it is much higher than hitherto obtained by other chemical processes from bagasse. A flowsheet of the hydrotropic process for pulp manufacture from bagasse, as well as of the recovery unit, is included.

223. McKee, Ralph H. Process of making paper pulp. U. S. patent 1,932,904 (Oct. 31, 1933).

Bagasse or like material is treated with a dilute alkali for a relatively short period at atmospheric pressure, the alkali-treated stock is subjected to the action of a mixture of chlorine gas and air at atmospheric pressure while spraying the stock with water, and the product is finally washed with a weak alkali solution. The apparatus is specified.

224. McKee, Ralph H. Recovery of cellulose and lignin from wood. U. S. patent 2,308,564 (Jan. 19, 1943).

The process consists of cooking a lignin-containing cellulosic material in a solution of certain hydrotropic salts for about 12 hours at about 150° C. Typical salts are the alkali salts of benzoic, salicylic, xylenesulfonic, cymenesulfonic, benzenesulfonic, phenolsulfonic, and toluenesulfonic acids. The alkaline earth salts are not quite as efficient. Sodium xylenesulfonate is preferred because, at moderate concentrations (e. g., 30 grams of salt and 70 grams of water), it is an excellent solvent; when diluted to approximately one third this concentration, it

loses almost all its solvent properties and lignin is precipitated. Details are given of the cooking operation.

225. McMULLEN, G. W. Paper from sugar-cane. *Paper Trade J.* 55, no. 25, 48 (1912); *Paper Makers' Mo. J.* 51, 81 (1913); *World's Paper Trade Rev.* 59, 168 (1913).

Brief mention, without any technical details, is made of the Simmons-McMullen process for the manufacture of pulp from bagasse. The sugar-cane, as soon as it is cut, is shredded and dried, in which condition it can be preserved indefinitely. The cellulose from the fiber produces a high-grade paper stock, and that from the pith a cellulose so low in ash that it takes the place of cotton in the manufacture of celluloid and nitrocellulose combinations, and also makes a nonconducting, ebony-like artificial wood. The president of the United Fruit Company believes that the statements are premature.

226. McMULLEN, G. W. Sugar-cane as stock. *Paper Makers' Mo. J.* 48, 248 (1910).

227. McQUISTON, RAYMOND C., and LOESECKE, HARRY VON. Method of treating bagasse and similar fibrous products for the production of pulp and the extraction of cellulose. U. S. patent 1,813,184 (July 7, 1931).—*T. S.* 94, 124; *C. A.* 25, 5286.

The first step in the proposed process is the mechanical separation of the pith from the fibers, preferably by the action of a swing hammer mill. The longer fibers, free from pithy material, are pulped with a solution of sodium hydroxide, with or without soda, in sea water. For every 100 pounds of dry fiber there are used 100 gallons of water, 15–18% of sodium hydroxide, and 5–8% of soda ash (on the weight of the dry fiber); the liquor also contains 2–4% of a soapy material (preferably an alkali cellulose in saponified fatty acids). Sodium bisulfite may be added to the extent of 4–8%. The pulping is carried out at 25–30 pounds per square inch gauge for 2–5 hours. The fibers are then washed, preferably with hot sea water and beaten, when they are suitable for the manufacture of kraft stock, cardboard and pressed and molded insulating materials, artificial lumber, etc. If desired, the pulp may be bleached with a solution of calcium hypochlorite in sea water. A pulp with 84% alpha-cellulose may be obtained by treating the bleached material with 5% sodium hydroxide, or with 93% alpha-cellulose by the use of 15% sodium hydroxide.

228. McRAE, WILLIAM A. R. M. Production of half-stuff paper-pulp or paper. U. S. patent 1,151,490 (Aug. 24, 1915).—*C. A.* 9, 2980.

The crushed bagasse is boiled with live steam under pressure with milk of lime (5–25% by weight of the dry weight of the raw material) for from 4 to 16 hours, depending upon the steam pressure, the grade of material, the type of digester, the quantity of lime, etc. The pressure may vary from 40 to 100 pounds per square inch. After the cooking operation, the product is preferably allowed to "mellow"; this is apparently a fermentation process. The stock is then washed thoroughly to remove pith and mucilaginous substances and disintegrated in a kollergang or edge-runner.

229. McRAE, WILLIAM A. R. M. Paper pulp from bamboo, bagasse or similar materials. British patents 213,003 and 213,004 (Dec. 22, 1922).—*C. A.* 18, 2249.

Bagasse, bamboo, and the like are beaten with water and nonfibrous carbohydrates, such as parenchyma, pith, starch, and sugar, are separated from the fibers and washed away. The separated nonfibrous material from bagasse may be collected, dried and used as a fuel. The second patent relates to a washing and beating apparatus for carrying out this treatment.

230. McRAE, WILLIAM A. R. M., and MALCOLMSON, N. Production of paper. British patent 26,043 (June 26, 1911); French patent 452,989 (March 20, 1912).—*J. Soc. Chem. Ind.* 31, 769.

Crushed bagasse is digested with water containing lime in the proportion of 5–25% of the dry weight of the material, for a period of 4–16 hours under a steam pressure which may range up to 100 pounds per square inch. The digested material is preferably allowed to mellow before being thoroughly washed in a potcher, in order to remove impurities which would be deleterious to the subsequent operations. The mass is then disintegrated in the kollergang and converted into paper pulp in the usual manner.

231. Make pulp from sugar-cane by new process. *Paper Trade J.* 86, no. 13, 22–3 (1928); *Paper Mill* 51, no. 13, 1 (1928).

Celulosa Cubana, S. A., has a plant at Tuinucu, Cuba, for the manufacture of bagasse pulp by the Roza process. In this process, the main efforts center about the production of a textile fiber suitable for spinning and weaving sugar bags; the fibers are admirably suited for the manufacture of paper. Alpha-cellulose suitable for rayon is being manufactured. A general description of the mill and its equipment is given, but few details of the manufacturing process. Sugar-cane fiber contains a large percentage of long and very strong cells and a much smaller percentage of ovoidal absorbent cells. The long cells derived from the exterior of the cane run up to 6 or 7 mm. in length, the average being about 3mm. The ovoidal cells are much shorter aad impart a remarkable degree of absorbency to the pulp. Thus, it is especially adapted for the manufacture of absorbents such as are now used in sanitary goods. It is also suitable for coated and similar papers and those using large amounts of china clay, the pulp possessing a marked capacity for taking up china clay because of its absorbency. Sugar cane pulp hydrates very rapidly, requiring only a few minutes to give the same results in the beater as are obtained with other pulps after several hours. Paper from bagasse shows a bursting strength of 91 and a tensile strength of 150; the folding strength is also high.

232. Making board from bagasse. *Boxboard* 1, no. 6, 16–7 (1922).

233. Making board from bagasse. *Paper Mill* 52, no. 44, 2, 42 (1929).

A general discussion is given of the manufacture of Celotex at Marrero, La.

234. Manns, Albert G. Process of preparing fibers from cornstalks and analagous pithy plants. U. S. patent 811,419 (Jan. 30, 1906).—*J. Soc. Chem. Ind.* 25, 280.

The raw material is boiled with water at atmospheric pressure for 3.5 to 4 hours (or for a longer period of time at a lower temperature or for a shorter time with superheated steam), the liquor removed, and the product then treated with a reducing reagent, such as sodium hydroxide or sulfurous acid. The treatment is mild enough to prevent the destruction of any large proportion of the pith cells. It may be desirable to separate the two kinds of fibers by a screening operation.

235. Manufacture of paper from sugar-cane bagasse. *J. Roy. Soc. Arts* 64, 132 (1915).—*J. Soc. Chem. Ind.* 35, 39.

The manufacture of paper from bagasse has been successfully carried out at a mill at Preston, Cuba, during the past year. At present, only wrapping papers are made, but the manufacture of other grades of paper is to be undertaken shortly. The output is consumed locally. The bagasse is digested with live steam, then transferred to the beaters, where it is mixed with bleaching powder. When sufficiently beaten, it is thinned with water before entering the paper machine.

236. Markoczi, Emeric, and Adam, Stephen J. Industrial application of strawlike materials. U. S. patent 1,534,236 (April 21, 1925).

The bagasse or similar material is allowed to undergo a natural souring (self-fermentation) at 100 to 125° F. and is then pulped with an alkali.

237. Marsden, Mark W. Method of treating bagasse and product thereof. U. S. patent 1,170,487 (Feb. 1, 1916).—*C. A.* 10, 985.

Bagasse is too valuable to be employed as a fuel and as a food for cattle. One ton of bagasse, when properly treated, will yield 80 gallons of acetone oil, 350 pounds of fertilizer, and 400 pounds of fiber; or, by another treatment, 125 gallons of alcohol, 550 pounds of fertilizer, and 400 pounds of fiber. According to this invention, the bagasse is first subjected to the action of dry heat in an oven or a heated revolving cylinder. This treatment is essentially slow and deliberate to avoid carmelizing and burning or charring. It is continued until the bagasse is thoroughly dehydrated, desiccated, or dried. The material is then cut into uniform lengths of ¾ to 1½ inches and treated for recovery of the fiber or baled for shipment or storage. The dried product is hydrolyzed or washed with water, generally by the application of steam at a pressure of 10 to 25 pounds, for 2 to 5 hours; the extract may be treated for the recovery of dissolved materials. The extracted stock may be pulped with a dilute alkali or sulfide solution. The resulting pulp is characterized by its clean, long, strong, and flexible fibers which may be used for newsprint or combined with other fibers.

238. MARSDEN, MARK W. Glucose and paper fiber from bagasse. U. S. patent 1,265,694 (May 7, 1918).—*C. A.* 12, 1709.

Bagasse is reduced to a uniformly divided state, all but about 10% of the natural moisture content is removed, and the pith is separated from the fiber. The pith is ground to about the fineness of flour, boiled with water to remove soluble matter, washed, pressed, formed into a paste, and treated with malt or diastase and with dilute sulfuric acid to obtain glucose. The fiber may be used in making paper.

239. MARSHALL, GEORGE H. Apparatus for producing cellulose from fibrous materials. U. S. patent 968,864 (Aug. 30, 1910).

This patent covers an apparatus for carrying out the pulping operation described in U. S. patents 971,457 and 982,379 [Nos. 240 and 241].

240. MARSHALL, GEORGE H. Process for reducing fiber-yielding materials. U. S. patent 971,457 (Sept. 27, 1910).

Bagasse or like material is digested in a rotary with from 3 to 10% of alkali (lime, chalk, or the like), steam being introduced into the digester for one to three hours. The pressure in the digester is then suddnely reduced to explode the pith or woody portion of the material. Finally, the material is passed through rolls to remove the moisture.

241. MARSHALL, GEORGE H. Process for producing cellulose from fibrous materials. U. S. patent 982,379 (Jan. 24, 1911).

Bagasse or other cellulose-yielding material is partially reduced in a digester by submitting it to a gradually rising steam pressure in the presence of a small amount of water and a mild neutralizing agent, after which the pressure is suddenly reduced during which the pith and woody matter are subjected to an explosive action; the material is then treated with a gradually rising steam pressure in the presence of water and a stronger neutralizing agent at a high temperature.

242. MARSHALL, GEORGE H. Apparatus for reducing fiber-yielding materials. U. S. patent 985,613 (Feb. 28, 1911).

This is an additional disclosure regarding the apparatus for use with the process covered by U. S. patents 971,457 and 982,379 [Nos. 240 and 241].

243. MASCARÓ, M. A. Bagasse paper pulp. *Mem. 16th conf. anual, Asoc. téc. azucar. Cuba,* 1942, 201–4.—C. A. 37, 6889; *B. A.* 1945 B II, 77.

The bagasse is precooked with high pressure steam and centrifuged; the absorbed vapor is then expanded suddenly with explosive force, thus separating the hard particles of fiber. The pulp is bleached, defibered, and washed. In this method (von Hildebrandt process), one ton of pulp can be obtained from 2.5 tons of bagasse at a cost nearly 50% lower than that of obtaining pulp from wood at the present time. Cane bagasse has practically no value in mills which have covered their heat balance.

244. MASON, CHARLES W. Making paper from waste sugarcane. *Pulp Paper Mag. Can.* 17, 1089–91 (1919).

A brief description is given of the paper mill of the Olaa Sugar Company, which was built to manufacture an asphalt-impregnated sheet from bagasse to be used for preventing the growth of weeds in sugar-cane fields. The bagasse is cooked for 12 hours with lime under 60 pounds pressure. It is then blown off and allowed to remain on the floor for 3–4 days before being used. The jumbo rolls of saturated paper are allowed to stand for 24 hours to give the asphalt a chance to penetrate the paper.

245. MASON, CHARLES W. Manufacture of paper from bagasse. *Paper* 34, no. 6, 240 (1924); *Paper Making* 43, 485 (1924); *World's Paper Trade Rev.* 82, 72 (1924).—*T. S.* 79, 189; *C. A.* 18, 2808.

This is similar to the preceding article. About 28 tons of bagasse are used each 25-hour period. The yield of mulching paper is about 62% (on basis of bone-dry bagasse). The rotary digesters are 14 x 14 feet and hold approximately 7 tons of bagasse. The author feels that bagasse pulp is suitable for boards but not for high-grade papers.

246. MASON, CHARLES W. Bagasse board and method of making the same. U. S. patent 1,627,103 (May 3, 1927).—*T. S.* 86, 66; *C. A.* 21, 2179.

The crude bagasse fiber is digested in rotary boilers with a solution of milk of lime, varying from 4 to 6% of the dry weight of the fiber, for 8 to 12 hours under

approximately 60 pounds of steam pressure. After refining, the pulp (while in the beater) is mixed with 10–20% of the raw fiber to increase the durability and tensile strength of the product. The mixture of raw and refined pulp is formed into sheets on a cylinder machine, which are then built up to the desired thickness (3/16 to 3/4 inch). The boards may be faced with the refined pulp. If desired, from 10 to 20% of Portland cement may be added, together with sodium silicate, rosin size, or the like.

247. Megass. *Paper Making* 27, 337–8 (1908).

248. Megass and bamboo paper in Trinidad. *J. Roy. Soc. Arts* 59, 974 (1911).

249. Megass. Its value as a material for the manufacture of paper and of artificial silk. Tropical Agriculture (Trinidad) 8, 200–2 (1929).—*C. A.* 23, 5586.

Bagasse, as received, contains 10.8% water, 1.2% ash, and 51.2% cellulose. A treatment has been devised which converts this material into a form suitable as a source of cellulose for paper and artificial silk, but it is believed that it is too expensive for present exploitation.

250. Miller, Warner. Rice straw and bagasse for paper pulp. *Paper* 20, no. 20, 24 (1917); *Paper Trade J.* 65, no. 3, 10 (1917).

The Sugar Cane By-Products Company has been incorporated to manufacture pulp and other products from bagasse and rice straw at New Iberia, La. The initial production will be 50 tons per day. The economics of the raw materials are discussed. The Paper Trade Journal item states that the process is that of W. W. Marsden. The estimated cost is $9.50 to produce from a ton of pulp: 550 pounds of paper pulp, estimated to be worth $27.50; 650 pounds of raw cellulose, $19.50; 15 gallons of alcohol, $5.25; 200 pounds of fertilizer, $1.00; total, $53.25.

251. Mitchell, John H. Composition paper or pulp board and method of making the same. U. S. patent 1,648,237 (Nov. 8, 1927).—*T. S.* 88, 200.

The comparatively straight and strong fibers from the stems and stalks of certain plants, particularly the bagasse of sugarcane, may be combined, interlaced, and felted with the comparatively crooked and branched fibers and pithy substances from the leaves of fleshy leaf plants, particularly the bagasse of the leaves of the sisal or henequen plant, and a strong, durable, and efficient paper or pulpboard produced, of varying stiffness, thickness, flexibility, and strength. It is preferred to pulp the bagasse and other fibers at a higher temperature under pressure and to use a stronger caustic solution than is usually employed in such processes; thus, a 60% caustic soda solution (containing from 4 to 12% of caustic on the dry weight of the plant material) is used and the digestion is carried out for 1 to 3 hours at a temperature above 212° F. A typical pulp mixture contains 60% of bagasse, about 20% of sisal leaf pulp, and 20% of waste paper.

252. Miyake, Suguru, Hamaguti, Eiziro, and Hirano, Shinzaburo. Utilization of bagasse. VIII. Preparation of paper pulp from bagasse by the soda-sulfite method. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 13, 261–6 (1941).—*C. A.* 42, 3175.

Dried bagasse was cooked with 14% commercial sodium hydroxide and 8.4% sulfurous acid at 180° C. for two hours to obtain paper pulp easily bleached (effective chlorine consumed 1.5% on the basis of the unbleached pulp), which contains 2.3% lignin and 29.5% pentosans. The yield of bleached pulp was 58.6%.

253. Miyake, Suguru, Hamaguti, Eiziro, and Ono, Kazuki. Semi-industrial preparation of pulp from bagasse by the soda and sulfate methods. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 16, 1–7 (1944).—*C. A.* 42, 2766.

Bleached soda pulp, prepared from bagasse in a 100-kg. digester in 48.5% yield, contained 71 to 73% α-cellulose; the sodium hydroxide consumption was 29.3% (10% higher than in a laboratory experiment) and the bleach consumption (bleaching powder) was 14 to 20%. Bleached sulfate pulp was obtained in 54% yield, with 22% sodium hydroxide consumption and 18–19% bleach consumption; it contained 72% α-cellulose.

253a. Molitor, John B. Economics of bagasse in paper manufacturing. *Sugar J.* 13, no. 1, 10–13, 28–29 (June, 1950).

The author announces that the Valite Corporation has carried out extensive tests on the use of bagasse for the manufacture of 9-point board. A surprising

variety of pulps can be prepared from bagasse in exceptionally high yields and at low costs. However, no details are given of the process. Bagasse at $5.00 per ton is only 30% of the reported cost of sufficient wood to produce an equivalent amount of pulp. The cost of producing 9-point board by the proposed Valite process is estimated to be 55% of the comparable cost from wood pulp. It is suggested that pulp as such might be marketed. The possibility of newsprint from bagasse is mentioned but the idea was discarded because the bagasse pulp would have to be mixed with a mechanical pulp (which is more expensive). Some figures are given on the potential annual production of bagasse (tons of bonedry material): United States, 816,000; Cuba, 2,260,000; Puerto Rico, 1,550,000; Brazil, 1,600,000; Hawaii, 925,000; Philippines, 750,000; Mexico, 720,000; Dominican Republic, 490,000; Argentina, 575,000; Australia, 150,000; India should produce six times as much as the United States. Not all this tonnage is available for pulping, since much of it must still be used as fuel.

254. Monclova, H. Cruz. The manufacture of paper in Puerto Rico. *Ciencia y técnica* (Puerto Rico) 1, 67–8, 89–90 (1943).—*C. A.* 37, 5237.

The use of bagasse for the manufacture of paper is discussed.

255. Norath, Edgar. Light building boards. *Wochbl. Papierfabr.* 66, 624–5, 661–4 (1935).—*T. S.* 103, 199.

In a general discussion of insulating boards, reference is made to the Celotex process.

256. Morganti, Lino. Fine paper from bagasse. *World's Paper Trade Rev.* 136, no. 5, 292, 294, 296 (1951).—*B. I. P. C.* 22, 122.

A fine paper mill is under construction at Monte Alegre, Brazil, which will use the Pomilio process for the manufacture of pulp from bagasse, eucalyptus, and rags.

257. Muench, C. B. The manufacture and uses of Celotex insulating materials. *La. Eng. Soc., Proc.* 7, 198–225 (1926).

A general description is given of the manufacture of Celotex from bagasse. Mention is made of the Ferox process of treating the board so that it is resistant to dry rot, decay, and the attack of termites. A partial list of the products manufactured is included.

258. Munroe, Treadway B. Industrial utilization of sugarcane fiber. *Proc. Second Dearborn Conference Agr., Ind. and Sci.*, 207–11 (1936).

A brief description is given of the development of the Celotex industry and of the possible future markets for this type of insulating material. No technical details are given.

259. Munroe, Treadway B. The utilization of bagasse in the manufacture of building and thermal insulating board. *Louisiana Planter* 69, 40–1 (1922).

260. Munroe, Treadway B. Method of preserving bagasse fibres and a bale thereof. U. S. Patent 1,479,419 (Jan. 1, 1924).—*T. S.* 79, 10; *C. A.* 18, 752.

The interior of a bale of bagasse is treated with a substance, like calcium oxide, which prevents fermentation and also reacts with the liquid constituents to generate sufficient heat to partially cook the mass while preserving the same. The baled fibers, when opened for pulping, possess their full strength and are also in a partially cooked or softened state, so that the normal cooking is greatly facilitated or even obviated.

261. Munroe, Treadway B. Method of preventing the natural deterioration of bagasse fibers. U. S. patent 1,503,202 (July 29, 1924).—*C. A.* 18, 2975.

Moist bagasse, because of its content of sugar and gummy matters, undergoes an alcoholic fermentation, which is followed by an acetic acid fermentation; this will continue until all the sugar and gums are consumed. If the bagasse is further exposed to the weather, it undergoes what is called a humic acid fermentation, which will destroy the strength of the fibers. These disadvantages are overcome if, at any time prior to the completion of the acetic acid fermentation, there is added to the interior of the mass a suitable insoluble compound having an alkaline reaction, such as lime, crushed limestone, crushed oyster shells, etc., either dry or mixed with water. The impregnated material is then subjected to a pressure sufficient to form over a portion or all of its surface, compacted,

substantially air-impervious layers of fibers cemented together by the sugar and gummy matters present in the bagasse.

262. MUNROE, TREADWAY B. Apparatus for cooking pulp-making fibers. U. S. patent 1,503,549 (Aug. 5, 1924).—*T. S.* 82, 9.

An apparatus for cooking bagasse and like fibers consists of a tank open to the atmosphere adapted to receive and hold such fibers and a solution capable of reaction on the fibers; a second tank comprising an open-ended drum, adapted to receive the solution and fibers from the first tank, with a means for transferring the fibers from the first to the second tank; means for heating the second tank; means for separating the fibers from the solution and for returning the solution to the second tank; and means for washing the fibers. Such apparatus is described and illustrated.

263. MUNROE, TREADWAY B. Process of treating bagasse for fiber-making purposes. U. S. patent 1,574,254 (Feb. 23, 1926).—*C. A.* 20, 1523.

Bagasse, baled at the mill, is piled in such a manner that a minimum of surface will be exposed to the weather and sufficient ventilation between the bales will be provided to permit moisture, vapors and gases to escape freely. A pyramid formation is obtained by disposing of the outer bales of the second layer well inside the outer bales of the lower layer. Acetic acid fermentation proceeds for a period of from three days to a month. It is desirable to open a few of the fermented bales and spread a layer of bagasse 6 to 8 inches thick over the entire pile of bales. Such a pile may be allowed to stand up to a year, during which time the fermented bagasse may be used for fiber-making purposes. The fermented bagasse may be cooked with water for a period of from 45 minutes to 2.5 hours; the cementitious material is removed, and the product is suitable for treatment in a Claflin or other refiner. The resulting fibers do not have all the properties desired for the manufacture of a heat insulating board, because they are rather long and coarse. This is overcome by the addition of from 10 to 50% of other fibers, such as mechanical pulp, waste newsprint, or fibers known as "close stock," or "wood pulp tailings." These are preferably added to the fermented bagasse in the cooker. The effect of these additions on the drying of the board is discussed.

264. MUNROE, T. B. Process for production of fibers for wall board and similar structures. U. S. patent 1,785,840 (Dec. 23, 1930).—*T. S.* 93, 36.

The process consists in subjecting the raw fibrous material (bagasse of the like) in large masses of bale-like proportions to a cooking action in the presence of a suitable chemical which may be produced from previous cooks, and which may include the products of condensation as well as the soluble salts and degradation products of previous cooks. The cooking is carried out at a temperature and for a time sufficient to subdivide the large masses into fiber bundles and to loosen the encrusting casing of the fibers, but insufficient to produce fibers for paper-making. These fiber bundles are subjected to a shredding action, whereby the fibers are freed from their cementing tissues and casings by hydraulic action under the force of rotating hammers, during which step the fibers will be classified according to size of the perforations in the plate below the rotating hammer. The final separation of the fibers is accomplished along the line of their longitudinal cementing tissues and, because of the resistant nature of the liquid in the shredder, as well as the high velocity at which the fibers are forced through the liquid, the bundles of the fibers will be separated so that the individual fibers will maintain their relatively long lengths and other natural characteristics, such as flexibility, strength, etc.

265. MUNROE, TREADWAY B., and COULTER, MARION D. Manufacture of fiber products. U. S. patent 1,968,418 (July 31, 1934).—*T. S.* 101, 50.

A method is proposed for incorporating toxic materials into fiber products. As an example, an insulating board composed of 75% bagasse and 25% pulped newsprint is considered. The pulped newsprint, at a consistency of 4–5%, is treated with an appropriate amount of ferric chloride and arsenious acid (e. g., 3.5% based on the dry weight of the fiber) with a ratio of arsenic to iron of about 1.25:1. The pH is adjusted to the appropriate point between 4 and 12, dependent upon the presence of electrolytes, to cause a change of the ferric chloride to hydrous ferric oxide which is adsorbed by the fiber and which, in turn, adsorbs the arsenic. The pulped newsprint with its adhered arsenic is then thoroughly mixed with the bagasse fibers and diluted to the proper consistency for board formation.

266. MUNROE, TREADWAY B., and LATHROP, ELBERT C. Preservation of fibers for pulp-making purposes. U. S. patent 1,739,645 (Dec. 17, 1929).—*C. A.* 24, 964.

The principle involved in this invention comprises taking the bales of fiber immediately after baling or before the initial fermentation process of converting the more soluble carbohydrates to alcohol and acids has stopped, and placing them in a suitable housing adapted for the elimination of air—in other words, the bales are placed in a structure having walls adapted to prevent, or substantially prevent, the passage of air therethrough. The bales are placed as close together as possible in layers and the crevices are filled with loose fiber. After one layer of bales is formed, a light layer of loose fiber is scattered over the upper surface and another layer of bales is laid down. After the structure is filled, a suitable roof is added to exclude rain or a light layer of chemicals may be sprinkled over the top layer of bales. In this method of storage, fermentation is stopped before the fibers are destroyed, through lack of oxygen.

267. MUNROE, TREADWAY B., and LATHROP, ELBERT C. Preservation of fibers. U. S. patent 1,813,632 (July 7, 1931).—*T. S.* 94, 110; *C. A.* 25, 5286.

According to this invention, a substantial stoppage of the destructive fermentation of the outside bales and even internally of the pile of bales can be brought about by the application of suitable disinfectant chemicals in a powdered form by sprinkling them along the contacting bale edges which will be exposed in the pile, as well as on the top surfaces of the exposed bales and on top of the pile, when it is completed. By this means, the moisture content of the fibrous mass is not increased, because the chemicals are added in dry form; when precipitation of rain or condensation of moisture on the outside bales or tops of the piles takes place, the moisture dissolves the dry chemical and carries it into the bale, maintaining a high degree of concentration so that the growth of micro-organisms is inhibited. The chemical is not required to go further into the bale than the excess moisture carries it, since the excess moisture is largely responsible for the deterioration of the fibers in the outside bales. Chemicals suitable for this purpose include the alkali, alkaline earth, copper, zinc, or other heavy metal salts of hydrofluoric acid, fluosilicic acid, borofluoric acid, or boric acid, or these acids themselves. In addition, organic compounds, such as sodium dinitrophenolate, beta-naphthol, and others are available. In an example, the use of four pounds of boric acid per ton of bone-dry fiber is suggested. The method of application is given in detail, including the method of piling the bales.

268. MUNROE, TREADWAY B., and LATHROP, ELBERT C. Felted material and method of manufacturing the same. U. S. patent 1,819,194 (Aug. 18, 1931).—*C. A.* 25, 5747.

The felted material covered by this patent is comparable with ordinary felt but is designed to have strength per given weight appreciably greater than that of ordinary felt and which, although flexible, has a superior resiliency. The raw material preferred is bagasse, but other fibrous materials may be used. The raw material is digested for 1 hour at a pressure of about 40 pounds per square inch (this may vary depending on the nature of the bagasse). This product is refined by the use of a beater, Jordan, Claflin refiner, passage through heavy rolls, or other means. This is termed free fiber, of which 35 to 100% are mixed with 65 to 70% of a close fiber (i. e., a free fiber which has been more highly hydrated, or a mechanical or sulfite pulp). The mixture is formed into a felted sheet which is then split into a number of thinner sheets.

269. MUNROE, TREADWAY B., and LATHROP, ELBERT C. Preservation of vegetable material in storage. U. S. patent 1,833,493 (Nov. 24, 1931).—*T. S.* 94, 310; *C. A.* 26, 1122.

In the formation of bales of bagasse, up to 1.5% of boric acid (on the dry weight of the material) is distributed on the material as evenly as possible. Other chemicals suggested include the alkali, alkaline earth metals, copper, zinc, and other heavy metal salts of hydrofluoric acid, fluosilicic acid, borofluoric acid, and the like. Organic compounds, such as sodium dinitrophenolate, beta-naphthol and the like, may be employed. The method of piling the bales is discussed.

270. MUNROE, TREADWAY B., and LATHROP, ELBERT C. Preparation and preservation of fiber. U. S. patent 1,854,557 (April 19, 1932).—*C. A.* 26, 3378.

Bagasse can be advantageously preserved and stored if the pith is first removed. This is best accomplished by subjecting the primary material to any well-known shredding action which, although physically dividing the mass into 2 fractions (the fibrous material and the pith particles), does not break down the natural characteristics of the individual fractions. The moisture content of the fibrous fraction is reduced to approximately 35% and that of the pith fraction to about 15%, and each is stored separately.

271. MUNROE, T. B., and LATHROP, E. C. Protective treatment of fiber products. U. S. patent 1,880,971 (Oct. 4, 1932).—*T. S.* 97, 259.

A method is proposed to protect fibrous material against the action of termites, which comprises the incorporation of a termite-repellent substance with the component elements which make up the final product, the application being made in the form of an emulsion or fluid suspension from which the termite-repellent material is precipitated on the elemental substances of the product prior to the final formation into the finished product. The chemicals comprise compounds of the benzene, naphthalene, and anthracene ring series in which hydrogen in the ring nucleus has been replaced by a halogen, various chlorinated phenols, chlorinated diphenyls, etc.

272. MUNROE, TREADWAY B., and LATHROP, ELBERT C. Fiber storage and preservation. U. S. patent 1,920,129 (July 25, 1933).

This patent covers primarily the method of forming a pile of bales of bagasse (convenient dimensions of such bales are 17 x 22 x 32 inches, such bales weighing about 250 pounds before and 125 pounds after drying out during the storage and preservation period), the dimensions of which may be 66 x 100 x 25 feet. During the erection of the pile, the desired fungicide or bactericide is applied along the outer top surface of the exterior bales of each layer prior to the placement of the next layer; the amount may be 0.17 to 0.2 pound per bale.

273. MUROTANI, KAN. Preparation of pulp from bagasse. I, II. Two-stage pulping method. Soda-chlorine method. *J. Soc. Chem. Ind. Japan* 47, 408–12 (1944); *C. A.* 43, 1970.

A two stage pulping method has been studied for the pulping of bagasse, using a soda-chlorine process. In the first stage the bagasse is treated with a sodium hydroxide solution for about five minutes at a temperature below 100° C., mechanical pressure being applied until the bagasse is disintegrated into vascular bundles. In the second stage the product from the first stage is decomposed to fiber with sodium hydroxide and chlorine. The resulting pulp has the characteristics of the original fiber and is suitable for paper manufacture.

274. NAKAMURA, YUZURU, and MIMA, YOSITUGU. Blending material for bagasse pulp. *Rept. Govt. Sugar Expt. Sta., Tainan, Formosa*, No. 7, 219–30 (1940).—*C. A.* 35, 5694.

The bark of *Crotalaria juncea* and *Sesbania sesban* was removed by a peeling machine in yields of 13.44 and 7.83%. The bark of *C. juncea*, pulped with 20% of soda at atmospheric pressure, gave a yield of 44% of raw pulp containing 90% of alpha-cellulose. The corresponding yields from *S. sesban* were 40 and 85%. Pulp from *C. juncea* had the greater tensile strength (0.85). This pulp, when mixed with bagasse pulp (yield of 34.6% of crude pulp with 88% alpha-cellulose) in proportions up to 50%, gave a thin and tightly textured paper that has 1.8 times the strength of paper made from bagasse alone.

275. NAKAMURA, YUZURU, and MIMA, YOSITUGU. Removal of the pith in the manufacture of pulp from bagasse. *Rept. Govt. Sugar Expt. Sta., Tainan, Formosa*, No. 7, 243–8 (1940).—*C. A.* 35, 5695.

In the manufacture of a good rayon pulp, it is necessary to remove 40–50% of the pith by winnowing and sifting. For paper stock a removal of 30–40% is sufficient.

276. NANJI, DINSHAW R. Alkaline pulping process. U. S. patent 1,679,441 (Aug. 7, 1928).—*T. S.* 89, 261.

The bagasse is passed through crushing rolls which disintegrate the material into lengths of 0.5 to 1 inch. One thousand pounds of this mass are triturated with 300 gallons of 4% sodium hydroxide, preferably near the boiling point;

after thorough mixing, the mass is transferred to a digester and heated with steam under pressure until the temperature reaches 185° C. It is maintained at this temperature for about 1 hour. The waste liquor is then pressed out, the material washed with hot water, and bleached in any suitable manner. If considerable quantities of pectin and sugars are present in the raw material, it is preferable to employ as a depectinizing agent a 0.5% solution of ammonium sulfate or other neutral salt of ammonia or of an alkali metal in quantities sufficient to immerse the material under treatment.

277. NANJI, DINSHAW R. Paper pulp. British patent 280,629 (August 17, 1926).—*C. A.* 22, 3300.

Woody or other cellulosic material is heated with a solution containing up to 4% of an alkali such as sodium hydroxide at high temperature and under pressure of about 10 atmospheres for about half an hour. Impure cellulose pulps, bagasse from sugar cane, grasses, and the like may be similarly treated and may be preliminarily crushed and treated with a dilute sulfuric acid solution under pressure.

278. NAYLOR, ISAAC. Wood substitute from waste fibrous materials. U. S. patent 1,528,224 (March 3, 1925).—*T. S.* 82, 40.

A raw material, such as bagasse, banana stalks, cornstalks, and the like, is dried and subjected to a grinding action to produce particles of the desired size, after which it is screened. The dry, screened material is treated with sodium silicate solution (20° Bé), so that the consistency is such that it can be stirred easily, and agitated for 2-3 hours. The water is then removed by steam until the remaining liquor has a density of about 40° Bé., the mixture is agitated until it has a thick muddy consistency, after which it is run into a mixing machine and 33% (by weight) of 40° Bé. sodium silicate is added; after thorough mixing, the product is run onto forming machines. The formed article (in a plastic condition) is subjected to hot live air impregnated with carbonic acid gas; the carbon dioxide liberates the silicic acid and removes gaseous products, thereby increasing the density and assisting in its solidification. After the formed article is thoroughly dried, it is passed through a bath of 40° Bé. silicate to which has been added 25% of water. Finally, it is passed through a bath consisting of 8% water and 1% sodium bicarbonate to set the impervious coating.

279. NAYLOR, ISAAC. "Wood substitute." U. S. patent 1,573,734 (February 16, 1926).—*C. A.* 20, 1508.

Cornstalk material, bagasse, or other waste vegetable fibrous material is used with a binder of sodium silicate. The product is treated with hot air, carbon dioxide, and sodium bicarbonate.

280. NEUMANN, JOHN. Art of paper making. U. S. patent 1,775,405 (Sept. 9, 1930).

Sugar cane, corn stalks, straw, or the like is digested with a solution containing four parts of sodium silicate and one part of potassium hydroxide (2 to 20% of the dry weight of the material) for about two hours. The process gives a yield of 75 to 88% of the cellulose actually contained in the material, as compared with 30 to 50% by previous processes.

281. Newsprint from bagasse. *Chemurgic Digest* 6, no. 12, 186; no. 18, 276 (1947).

A short note indicates that newsprint will be manufactured in Mexico from sugar cane bagasse obtained from the Zacatepec mill. The paper mill is expected to have a daily production of 20,000 tons. The process is not indicated but is said to be similar to that used in Cuba, India, the Philippines, and Hawaii.

282. NICOLL, WILLIAM D. High alpha-cellulose pulp. U. S. patent 1,931,933 (Oct. 24, 1933).—*T. S.* 99, 22.

The raw bagasse is shredded and screened, about 35–40% of the original weight of the material being removed (pith). This material is then treated with 6–9% sodium hydroxide at a temperature of about 140° C. and 50 pounds pressure for about 7 hours. A countercurrent principle is used so that the fiber is treated with liquors containing progressively increasing concentrations of active cooking liquid and decreasing concentrations of dissolved organic material. An optional treatment with water at 130–160° C. under pressure may precede the digestion phase. The crude pulp is washed free of cooking liquors, screened to remove shives, and bleached by means of a two-stage process—chlorine water and hypo-

chlorite. Finally, the pulp is washed with an acid solution and then with pure water. The product is stated to contain not less than 95% alpha-cellulose.

283. Noble, G. R. Cornstalks and bagasse. *Paper Trade J.* 49, no. 1, 44 (1909); *Pulp Paper Mag. Can.* 7, 218–9 (1909); *World's Paper Trade Rev.* 50, 1004–5 (1909).

284. Nunez, V. E. New sources of raw material for paper pulp in the United States. *Papier-Fabr., Fest- u. Auslandheft*, 1914, 41–4.—*J. Soc. Chem. Ind.* 33, 744.

Of the minor sources of supply of papermaking materials, sugar-cane refuse, previously shredded and largely freed from pith by the Simmons process, is considered the most promising.

285. Ono, Kazuki. Preparation of pulp for paper from bagasse. I. The minimum quantity of sodium hydroxide required in the soda process and the quality of pulp prepared. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 13, 89–100 (1941).—*C. A.* 42, 3175.

With air-dried bagasse (water content 11.6%; the pithy part, amounting to 30%, had been separated), 11–12% sodium hydroxide was sufficient for the production of brown pulp and 12–13% for bleached pulp. The yield of brown pulp was 54% and that of bleached pulp 50.1% (α-cellulose 73%, pentosans 31–32%). The length of the fibers varied from 0.5 to 5.0 mm. and the average width was 15.2 microns.

286. O'Rourke, C. H. Separating pith from fiber or bagasse. U. S. patent 1,260,437 (March 26, 1918).—*C. A.* 12, 1602.

The patent relates to evaporation of moisture in successive stages, and to mechanical treatment to separate the pith and fiber.

287. Ortiz, Sanchez. Puerto Rico mill will use sugar cane bagasse. *Converter* 17, no. 9, 12 (1943); *Fibre Containers* 28, no. 9, 12, 14 (1943).—*B. I. P. C.* 14, 43.

The Development Company of Puerto Rico is establishing a board mill utilizing bagasse and waste paper as raw material; the board will be converted to boxes. The project is sponsored by the insular government of Puerto Rico. The factory will have a capacity of 12,000 tons of board a year, from which 5,000,000 boxes can be made.

288. Owen, William L. Integrating by-products utilization with sugar manufacture. *Facts About Sugar* 35, 38–40 (1940).—*C. A.* 34, 4603.

Butanol obtained from molasses by fermentation can be used for producing alpha-cellulose from bagasse. The bagasse can serve as a fuel and the surplus can be converted into fiberboard.

289. Paper from bagasse. *Am. Sugar Ind.* 13, 399 (1911).

290. Paper from bagasse. *Chimie et industrie* 2, 537 (1919); *Paper* 24, 712 (1919).

A paper mill with a daily capacity of 165 tons is being erected at Olaa (Hawaii) for the manufacture of all kinds of paper. This production will utilize only 10% of the available supplies of bagasse of the sugar factories of Olaa. The mill has been planned with a view of being gradually expanded so as to ultimately utilize all the available supplies of bagasse, should the venture be successful, in which case the output could reach 165 tons a day and even more, should the factories in the other islands follow this good example. The mill cannot start for another year as the required machinery could not be obtained during the war.

291. Paper from bagasse. *Papier-Ztg.* 28, 2891 (1903).—*J. Soc. Chem. Ind.* 22, 1145.

Because of the length and elasticity of the fiber, bagasse, if properly treated, yields a very good halfstuff, eminently suitable for strong wrapping papers. Experiments conducted on bagasse from Java showed a yield of halfstuff of 48%. This was very tough and could be bent several times without breaking. These properties are considered better than those of straw pulp, which is extensively used for papermaking; they should be capable of still further improvement by more prolonged beating. The repeated failures of enterprises for making paper from bagasse in tropical countries are attributable to industrial and economic difficulties and not to the nature of the fiber.

292. Paper from bagasse. *Papier-Ztg.* 43, 827 (1918).

293. Paper from bagasse. *World's Paper Trade Rev.* 134, 855–6, 858, 860, 862 (1950).—*B. I. P. C.* 21, 228.

Fine paper has been successfully produced from bagasse for some time by the Cia. de Celulosa de Filipinas mill in the Philippines. Other mills which are preparing to use this raw material are mentioned. Although bagasse has been considered a waste product and has been burned under steam boilers by sugar factories in the wet state as received from the processing machines, new drying methods have been developed which will increase its calorific value and, in turn, the supply available for papermaking. The pulping process used for bagasse is the Celdecor-Pomilio continuous soda-chlorine process which is illustrated in a flow diagram. In addition to its use in making fine paper, bagasse, either alone or in combination with semichemical or kraft pulp, has been used in producing insulating and corrugating board and wrapping papers.

294. Paper from bagasse pulp is demonstrated in the "paper city." *Paper Ind.* 31, 1294–5 (1950); *Printing Equip. Engr.* 70, no. 6, 42 (1950).—*B. I. P. C.* 20, 469.

In order to show that 100% bagasse pulp can be employed to make commercial grades of paper suitable for newsprint, a demonstration was given at the Chemical Paper Manufacturing Co., Holyoke, Mass., on Jan. 28, 1950. A special edition of the *Holyoke Daily Transcript* was printed on the paper made from the bagasse pulp. The experiments were carried out by the Kinsley Chemical Co., Cleveland, under the direction of E. R. Timlowski. Cf. No. 38.

295. Paper from sufar cane. *Papier-Ztg.* 38, 3399 (1913).

296. Paper from sugar cane bagasse. *Canadian Department of Trade and Commerce States; Weekly Bulletin. Paper-Maker* 50, 409 (1915).

This is a brief statement regarding the manufacture of paper from bagasse at Preston, Cuba. Three weights of wrapping paper are made, the highest being 80-pound. The paper is stated to be equal to, if not slightly better than, that made from imported kraft.

297. Paper pulp—Kinsley opens pilot plant in Cleveland, also directs Argentine operation. *Chemurgic Digest* 9, no. 12, 12–13 (1950).—*B. I. P. C.* 21, 326.

Mention is made of Fibrocel Argentina, a newsprint mill which will utilize bagasse and wheat straw. It is described as the first operation of size in the world to produce newsprint from the fibers of annual growth.

298. Paper-making from megasse and bamboo. *Paper-Maker* 42, 568 (1911).

The magazine *Tropical Life* quotes a report from an "eminent" firm of engineers, who state: The percentage of fiber (in bagasse) is very low and we do not think that it is possible to produce high-quality paper from megasse in a profitable manner. Megasse produces a hard, parchment-like paper but when the megasse fibers are mixed with bamboo, the paper is much more pliable and is cleaner. Bamboo is considered a much more suitable material than megasse. It is concluded that megasse cannot be profitably worked into a superior class paper, but it could be used for wrapping paper or boards. There is also that question of the fuel value of megasse to be considered.

299. Papermaking prospects in Egypt. *Paper* 25, no. 1, 27; no. 7, 36 (1919).

Experiments in Egypt on the use of bagasse as a papermaking material have not proved commercially successful. In districts where coal is scarce, it is more profitable to use megasse as a fuel.

300. Papermaking qualities of bagasse. *Bull. synd. fab. papier et carton* No. 9, 135–6 (May 15, 1920).—*C. A.* 14, 2553.

The following results were obtained by J. Maheu and L. Matrod at the Laboratoire Général des Productions Colonailes: Bagasse contains 39% cellulose and 50% lignin, from which handsheets were prepared. The paper was slightly colored and grainy to the touch, had a satisfactory tensile strength, and a somewhat lower tearing resistance. The pulp contains an appreciable quantity of cells with low felting power. Before bagasse can be used for papermaking, some other satisfactory fuel must be found for the sugar factories.

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301. PATTISON, A. P., & COMPANY. The sugar industry in Formosa. Shanghai, China, 1947. 23 p.—*C. A.* 41, 3987.

Among the topics considered is the production of bagasse pulp during the war.

302. PAULL, A. R. Bagasse as a papermaking material. *Paper Trade J.* 71, no. 13, 38 (1920).—*C. A.* 14, 3528.

This is a brief description of the manufacture of paper from bagasse. If properly prepared, one ton of bagasse will yield 840 pounds of pulp. The digestion requires 2–2.5 hours and chemical costs are much less than for wood. The fiber is very fine but is stronger than wood pulp. Sufficient bagasse is produced annually in Louisiana, Mexico, Puerto Rico, and Cuba to produce more paper of all grades than is used in the entire world.

303. PAYNE, JOHN H. Nitric acid process for recovery of cellulose from bagasse. *Ind. Eng. Chem.* 26, 1339–41 (1934).—*T. S.* 101, 218; *C. A.* 29, 921.

In a repetition of the method of Lynch and Goss (No. 164), digestions were carried out at room temperature for 3 hours; this was followed by draining, heating for 1 hour at 80° C., washing, caustic boil, and bleach. Concentrations of nitric acid below 3% did not produce satisfactory pulps; no decrease in the quantity of nitric acid used was found with concentrations of 3 and 4%. The addition of hydrochloric acid had no effect in any case. All of the pulps were characterized by a high soda-soluble value and only fair quality as regards alpha-cellulose. Bleach consumption was high in every case. Therefore, digestion at higher temperatures was investigated. The following procedure was used: Digest for 1 hour at 90–100° C. with nitric acid solution (ratio, 10 acid to 1 bagasse); drain, wash, and recover nitric acid; boil 45 minutes with 2% sodium hydroxide solution; wash thoroughly and bleach by the Rue and Sconce method [*Paper Trade J.* 95, no. 17, 54–62 (1932)]. The following conclusion was drawn from experiments in which the concentration of nitric acid was varied from 1 to 5%: The optimum concentration of nitric acid is about 2%. Increase in the time of digestion above 1 hour does not materially improve the quality of the pulp. The yield of pulp recovered decreases with the increase in the concentration of the acid but the yield of alpha-cellulose increases as the pulp yield decreases. With 2% nitric acid, the pulp yield averaged 38%. On a commercial scale, it might prove more profitable to use 1.5% nitric acid to take advantage of the increased pulp yield (43%), in spite of the lower alpha-cellulose yield. The ash content in every case is below 0.3%. The soda-soluble value, although much lower than in the Lynch and Goss procedure, is slightly high in all cases. The recovery of nitric acid appears to be highest with the 2% concentration of acid. The alpha-cellulose content was increased, on the average, by 2% and the soda solubility decreased 3% by allowing the pulp to stand for 30 minutes in cold 5% sodium hydroxide solution. By boiling for 30 minutes in 5% sodium hydroxide, the alpha-cellulose was increased from 3 to 5% and the soda solubility decreased 3 to 6%; this pulp contained 95.7% alpha-cellulose and showed a soda solubility of 6.7%; the yield was 33%. The bleach consumption for the pulp obtained with 2% nitric acid was less than 5% by weight of the dry pulp. It is calculated that the cost of chemicals would be less than $10.00 per ton of pulp.

304. PEMBERTON, HENRY. Manufacture of paper from sorghum. U. S. patent 38,059 (March 31, 1863).

Chinese sugar cane (*Sorgo sucre*), after crushing and extracting with water to remove the sugar, is boiled in an open vat with about 10% of caustic soda for 8–10 hours. The stalks are washed with water and then with very dilute sulfuric or hydrochloric acid, and bleached with chloride of lime.

305. PHILLIPS, S. CHARLES. The empire's resources in papermaking materials. *Paper-Maker* 49, 627, 629, 631, 634 (1915); 70, 25–35, 143–9, 257–65 (1915); *Intern. No.* 1914–1915, 45–74; *J. Roy. Soc. Arts* 63, 613–32 (1915); *Paper* 16, no. 12, 13–4 (1915).—*J. Soc. Chem. Ind.* 34, 655.

Under Trinidad, the author discusses briefly the possible use of bagasse as a paper-making material. Reference is made to the work of Bert de Lamarre and of the use of a mixture of bagasse, bamboo, and Para grass. [No. 177, 178]

306. Pomilio, Umberto. The use of chlorine gas in industrial pulp manufacture. *Proc. Tech. Section, Paper Makers' Assoc. Gt. Britain, Ireland* 19, 17–51 (1938).—*B. I. P. C.* 8, 328; *C. A.* 32, 3956, 5623; *T. S.* 108, 122; *B. C. P. A* 1938B, 770.

On page 47, the author mentions that he has tested many samples of bagasse by the chlorine process and has reached the conclusion that bagasse pulps or semipulps may be a useful addition to the papermaker's list of fibrous raw materials.

307. Pomilio, Umberto. Continuous process for the manufacture of semipulp. U. S. patent 2,178,266 (Oct. 31, 1939).

A continuous process for the manufacture of semipulp from straw, bagasse, and the like, which consists in mixing the raw material with 1% alkali solution in the proportion of 3 parts by weight of the solution to 1 part of straw; the mixture passes through a reaction tower at a temperature of between 75° and 100° C. at such rate that it remains in the tower for 1 to 4 hours; after washing and dewatering, it is introduced, together with chlorine gas diluted with air in proportions of 0.5–1 part by volume of air to 1 part by volume of chlorine in such quantities that there are 4–5 parts by weight of chlorine introduced to 100 parts by weight of the raw material, into the reaction vessel through which it passes in from 0.5 to 3 hours; the material is then immersed immediately into a cold water bath, from which it is transferred to a vessel where it is treated with 0.1% alkali in quantities from 5 to 20 parts by weight of solution to 1 part of vegetable material. *See also* British patent 489,302 (No. 310).

308. Pomilio, Umberto. Apparatus for the extraction of cellulosic fibers from vegetable material. U. S. patent 2,263,903 (Nov. 25, 1941).—*C. A.* 36, 1777.

This is apparently the same as British patent 480,170 (No. 309).

309. Pomilio, Umberto. Process and apparatus for extracting cellulose fibers from vegetable materials. British patent 480,170 (Feb. 15, 1938).—*C. A.* 32, 6060.

Cellulose fibers suitable for paper or board are extracted from bagasse, straw, etc., by treating the material with alkali (e. g., 1–2% sodium hydroxide solution) at 80–100°, then treating with chlorine at a temperature not exceeding 65°, and immersing in cold water immediately after the chlorination treatment. The reactions are controlled as to concentration of solution and time of treatment to ensure that the above temperatures are not exceeded and thus prevent damage to the fibers. Just sufficient alkali is used to react with the encrusting substances. After the chlorination, the material may be treated with 0.1–1% alkali solution at up to 100°.

310. Pomilio, Umberto. Extraction of cellulosic fibers from vegetable material. British patent 489,302 (July 25, 1938).—*C. A.* 33, 378.

Semipulp, suitable for papermaking and cardboard, is prepared from fibrous vegetable matter, e. g., bagasse, straw, etc., by treating it with alkali, e. g., sodium hydroxide of 1% or less, at 75–100° and then with chlorine without application of heat, and, if desired, with cooling, the quantities of reagents used being not more than sufficient to remove a part only of the non-cellulosic constituents. The chlorine reaction is preferably followed by another treatment with very dilute alkaline solution, e. g., sodium hydroxide of 0.2% or less.

311. Pomilio soda chlorine process. *World's Paper Trade Rev.* 111, 878, 880 (1939).

In listing plants in operation or in prospect, based on the Pomilio chlorine process, mention is made of a license granted to a mill in the Philippines; a new mill and plant planned, erection shortly and production expected to commence early in 1940. The raw material is to be bagasse.

312. Port Ensui Pulp Industrial Company. Elimination of ash from the sulfite waste liquor of bagasse prepared by the magnesium sulfite method. Japanese patent 163,146 (Marsh 23, 1944).—*C. A.* 42, 3962.

By adding 1.5% oxalic acid to the waste liquor from bagasse pulp prepared by magnesium bisufite method and heating, sulfur dioxide is expelled and magnesium, calcium, iron, alumina, and other metals are precipitated as oxalates.

313. POSSANNER, BRUNO VON. Bagasse as a papermaking material. *Wochbl. Papierfabr.* 42, 1157–8 (1911).—*J. Soc. Chem. Ind.* 30, 483; *C. A.* 5, 2945.

The author agrees with the views expressed by Wrede [No. 436] as to the possible future of bagasse as a raw material for white papers. It is desirable, however, to separate the small parenchyma cells of the pith from the useful fibers before attempting to bleach the pulp. Such separation is readily performed by mechanical means. The pulp yielded 30% of long fibers and 60% of small cells, 5–10% being lost. When bagasse celluose is prepared by the alkaline process, it consists of a brown product which is practically incapable of being bleached. On the other hand, an alkaline process is absolutely necessary to break down the highly siliceous tissues of the outer portion of the stem. A double treatment, first with sodium hydroxide and then with bisulfites, yields a well-digested pulp which can be bleached perfectly white with 6–10% of bleaching powder; it is necessary to bleach in acid solution. In the laboratory, the yield of cellulose ranges from 35 to 50%; on the large scale, a maximum of 40% may be expected, because a portion of the small cells must be lost. Only by this combined acid and alkaline process of digestion can bagasse be used as a raw material for the manufacture of fine white papers.

314. PRICE, HERBERT T. Process of treating bagasse preparatory to pulpboard making. U. S. patent 1,656,829 (Jan. 17, 1928).—*T. S.* 87, 228; *C. A.* 22, 1041.

The bagasse is heated in large open vats; when the boiling point is reached, sodium hydroxide is added and the suspension is heated and stirred for an hour; the pulp is then run through one or more sets of tension rollers, which loosens the pith from the fibers. By again boiling the pulp for about an hour, the pith separates from the fibers.

315. PRICE, HERBERT T. Preparation of boards from bagasse. U. S. patent 1,696,896 (Dec. 25, 1928).

A mixture of 80% by weight of bagasse and 20% of ground ti-tree or its bark is used for manufacturing a pulp board. The bagasse is first softened by soaking in sodium hydroxide; after mixing, the material is boiled with a solution of lime of sodium hydroxide for 1–2 hours; the cooked product is then run onto a woven wire belt which has a to-and-fro motion, so that the fibrous portion of the bagasse is forced to the bottom of the intended board and the ti-tree bark and the pith of the bagasse are brought to the surface.

316. PRINSEN-GEERLIGS, H. C. Paper from bagasse. *J. fabr. sucre* 50, 7 (1909); *Papier-Ztg.* 36, 1644 (1909); *Papier* 12, 121 (1909).—*Auszüge* 1909, 72.

Dry bagasse can be worked up only with difficulty; therefore, it should be used in its original moist condition. Upon heating bagasse with water alone at 6 atmospheres pressure, a dark brown product is obtained in a yield of 45%; with lime, the yield is 47%. White pulp can be prepared only by substituting a part of the lime with sodium hydroxide, but this gives a yield of only 31%. Because of the high prices of sodium hydroxide and of coal in the colonies, the use of bagasse as a paper-making material is of doubtful value. Bagasse is the principal fuel of the sugar mill.

317. PRINSEN-GEERLIGS, H. C. Sugar cane bagasse as a material for the manufacture of paper. *Centr. Zuckerind.* 17, 12 (1908).—*C. A.* 3, 117.

The author believes that, because of the work necessary to separate the incrusting materials from the fiber to prepare a good grade of paper and because of the low percentage of fiber, bagasse would made a too expensive raw material. Further, bagasse has too great a fuel value for the boilers to be utilized economically for paper stock.

318. PROBOSCHT, HUGO. Proposals for the chemical-technical utilization of cellulose and by-products in the manufacture of paper. *Zentr. Papierind.* 54, 63–5 (1936).—*C. A* 31, 8185.

In a discussion of the raw materials for the manufacture of paper in Brazil, mention is made of soda pulp from bagasse.

319. Progress of papermaking from bagasse. *Paper* 7, no. 8, 29 (1912).

This news item states that the Simmons plant for desiccating sugar cane (located at Central Preston, Cuba) has made its first shipment of dried fiber to beet-sugar factories in Wisconsin. Mention is also made of the manufacture of paper from a combination of bagasse and bamboo fibers.

320. Pulp from bagasse in South. *Paper Trade J.* 65, no. 3, 10 (July 19, 1917).

A news story carried information regarding the Sugar Cane By-Products Company, which has a mill at New Iberia, La., for the manufacture of pulp from bagasse. The Marsden process will be used. Cost figures are given.

321. Pulp from sugar cane. *Papier-Fabr.* 7, 66–7 (1909).

322. Quinones, Victor L. The production of alpha-cellulose by the use of bagasse and the leaves of sugar cane as raw material. *Rev. agr., ind. y com., Puerto Rico* 31, 462–5 (1939).—*B. I. P. C.* 11, 191; *C. A.* 35, 644.

The bagasse and leaves of sugar cane were purified by steam and then digested with butyric acid in a water bath. The butyric acid was obtained by fermentation of molasses.

323. Rae, William F. Utilization of waste bagasse from sugar-cane. *Pacific Plastics* 6, no. 10, 20, 22 (1948).—*B. I. P. C.* 19, 144.

About half of the bagasse produced—8–10 tons for every ton of raw sugar—is burned for power and light for the mill; the remainder must find another outlet. Research by the Kekaha Sugar Co. in Hawaii on the impregnation of bagasse with a thermosetting phenolic-type resin has resulted in a new hard-board which is economical, termite and moisture resistant, and attractive in the natural state; it can be painted or covered with paper overlays, and works much like wood. Plans are now under consideration for a full-scale production plant.

324. Raitt, William. Bagasse as a papermaking material. *Tropical Agriculturist* 34, 11–2 (1910); *World's Paper Trade Rev.* 53, 968–9 (1910); *Paper-Maker* 40, 64–5 (1910); *Paper Makers' Mo. J.*, 48, 247–8 (1910); *Paper Trade J.* 50, no. 25, 36 (1910); *Papier-Fabr.* 8, 665–6 (1910); *Rev. ind. agr. Tucuman*, 1, no. 12, 38–41 (1910).—*J. Soc. Chem. Ind.* 29, 1003; *C. A.* 5, 196, 3154.

Bagasse contains 50% of available cellulose; with a comparatively mild soda treatment, it could be depended on to give, in mill practice, an average yield of 45% of air-dry unbleached pulp. The stage at which sugar cane holds its maximum saccharine content appears to coincide with a state of partial and irregular maturity of the fiber. Because of this, it is necessary to use a chemical treatment severe enough to digest the most resistant fibers; this fact probably accounts for the varying yields reported by different experimenters. The author's preference for pulping conditions are those which will give the largest yield, regardless of the bleaching properties, in view of the opinion that bagasse pulp can be used only for coarse unbleached paper, such as wrapping and packing papers. It is estimated that the profit in manufacturing paper from a ton of bagasse would be £1 12s. 6d.

325. Redgrave, G. R. Pulp and paper supplies from the tropics. *Paper Makers' Mo. J.* 64, 391 (1926).—*C. A.* 21, 494.

The application of the "Nivoc" pulping process to bagasse and other tropical fibers is discussed.

326. Reifergerste, —. Is bagasse suitable for pulp production? *Wochbl. Papierfabr*, 61. no. 25A, 45–7 (1930).—*C. A.* 24, 5155.

Though all the problems of manufacture have not been solved with entire satisfaction, the quantity and quality of pulp now being produced from this material compel an affirmative answer.

327. Remington, J. S., Bowak, D. A., and Carrington, A. J. B. Megass in papermaking. *World's Paper Trade Rev.* 52, 729–31 (1909); *Papier-Fabr.* 8, 1185–7 (1909; *Paper Mill* 32, no. 47, 2, 34 (1909).—*J. Soc. Chem. Ind.* 29, 16; *C. A.* 4, 826.

A sample of bagasse from Trinidad gave the following analysis: moisture 11%, ash 1.5%, loss on alpha-hydrolysis 30%, loss on beta-hydrolysis 48.7%, loss on mercerization 32.7%, gain on nitration 10.2%, cellulose 47.1%, length of ultimate fiber, 3.5 mm. The fiber is highly lignified and somewhat irregular in length and in its distribution in the stem. The best and most profitable method for converting the material into pulp consists in digesting it with 7–10% of sodium hydroxide for 12 hours under a steam pressure of one atmosphere. This comparatively mild treatment yields 45–50% of pulp, as against 38–40% in the case of the more severe treatments, which destroy a portion of the less resistant cellulose. The method of pulping proposed involves particular care in the subsequent

beating of the pulp. A satisfactory bleached pulp is obtained with the consumption of about 15% of bleaching powder and 1–2% of other chemicals. The excessive quantities of bleaching agents, which are required to bleach the pulps obtained under more severe conditions of digestion, are consumed by the products of decomposition of the cellulose, which are absent when the pulps are boiled under low pressure. Bagasse pulp, when used alone, invariably yields a stiff hard paper, in whatever way it may be treated in the beater; further, it is not easy to obtain a paper which is free from coarse fibers. By a system of gradual beating, it is possible to obtain papers of great strength, but if the beating is overdone, as very readily happens, the strength of the paper suffers considerably. Bagasse pulp, when mixed with other fibers—e. g., chemical wood pulp, lalang (*Andropogon caricosus*) grass, or Para grass, gives papers which are eminently suitable for printing and which do not possess the harshness of the pure bagasse products. The authors have made and tested several samples of paper of pure and mixed fibers and speak very favorably of the possibilities of the bagasse fiber as a material for papermaking.

328. Remler, Raymond F. Paper pulp. U. S. patent 2,068,151 (Jan. 19, 1937).—*C. A.* 31, 2006.

In the pulping of bagasse, straw, grass, cornstalks, etc., by the alkaline process, the addition of a small amount of an introfier to the cooking liquor increases its rate of penetration and very materially shortens the time required for pulping. The introfier also decreases the amount of alkali required for cooking and decreases the amount of washing required by the pulp. Some 19 compounds were tested, the best of which were turpentine (preferred), chloroform, lauryl alcohol, methylcyclohexanol, perchloroethylene, and pyridine. In the case of turpentine, about 2 to 7 gallons are used per ton of straw treated. This amounts to adding from 0.5–2 pounds of turpentine to each hundred gallons of alkaline cooking medium, assuming that about 1.6 pounds of medium are used for each pound of straw at the start of the cook.

329. Richter, George A. Process of treating fiber of nonconiferous origin. U. S. patent 1,780,539 (Nov 4, 1930).

Pulp from bagasse, bamboo, birch, or poplar, etc., obtained by the sulfite process, is digested at a consistency of about 10% with a sodium hydroxide solution of a concentration of 4–10% at temperatures below 70° C. The treatment is continued until the original pentosan content of 7–12% is reduced to 2–5% (about 1 hour). After washing, the yield of treated fiber is 80–85%. The treated pulp is much softer, possesses materially higher tear resistance, and is better suited for use as a raw material in the preparation of cellulose derivatives than the untreated fiber. The color of the treated fiber may be improved by pretreatment with a relatively dilute solution of chlorine or bleaching powder.

330. Richter, George A. Fiber from bagasse or the like. U. S. patent 1,811,864 (June 30, 1931).—*T. S.* 94, 125; *C. A.* 25, 5026.

Bagasse is charged into a liquor initially containing from 7 to 12% caustic soda equivalent in the form of either caustic soda or sodium sulfide, alone or in admixture; the cook is effected at temperatures not above the atmospheric boiling point and even at temperatures as low as 70° C. for 4 to 8 hours. In place of raising the liquor directly to its boiling point, it may be maintained at about room temperature for 1–3 hours, to permit penetration of the cooking liquor into the stalks, after which the liquor is raised to the desired temperature and maintained at that point for 4–8 hours. In the latter case, the steeping treatment at room temperature is preferably carried out in a more concentrated liquor, which is then diluted before the cooking operation. Yields of fibers of 45–60% are obtained, containing 85–95% of cellulose and 8–14% of pentosans; the stock is suitable for wrapping and bag papers. It is possible to lighten the color of the fibers by a bleaching agent.

331. Richter, George A. Fiber liberation from cellulosic materials such as wood, hemp, bamboo, or bagasse. U. S. patent 1,841,551 (Jan. 19, 1932); Canadian patent 284,219 (Oct 23, 1928).—*T. S.* 95, 51; *C. A.* 23, 707; 26, 1785.

A process which may be applied to bagasse, hemp, bamboo, and hardwood consists in cooking the raw material successively in a sulfurous acid solution, a bisulfite solution, and an alkaline liquor, keeping the material short of complete fiber liberation until the alkaline liquor is used. In the first step a liquor containing 2–5% sulfur dioxide is used at a temperature of 230–260° F. for about

2 hours; thereafter, a concentrated solution of sodium hydroxide, sodium sulfite, or sodium sulfate is added until the combined sulfur dioxide content is 1–2% or greater and the treatment is continued at a temperature of 250–300° F. for about 2 hours. Finally, the alkaline cook is carried out with sodium hydroxide and sodium sulfide, using a temperature of 300–335° F. for about 2 hours.

332. RINMAN, E. L. Process for pulping straw, esparto, reeds, etc. U. S. patent 1,716,006 (June 4, 1929); Canadian patent 284,182 (Oct. 23, 1928); French patent 631,088 (Sept. 6, 1927).—*T. S.* 91, 11, 74.

Pulp is produced from sugar cane, straw, and like materials by boiling with sodium hydroxide, with or without sodium sulfide, at a temperature between 100 and 140° C., in such a manner that glutinous substances present in the raw material are not dissolved from the cellulose but may be utilized in the production of paper. The resulting pulp is suitable for parchment paper or greaseproof paper. Details of the pulping are illustrated for rye straw. The pulp is beaten in such a way that the fibers are not cut or tor and has a degree of beating equivalent to 65–80 degrees Schopper-Riegler. If it is desired to produce a thicker paper, the pulp is heated to about 30–40° C. before it is delivered to the paper machine.

333. RITTER, ERNEST A. Fermentation process for the preparation of paper pulp from bagasse and similarly incrusted cellulose fibers. U. S. patent 2,193,493 (March 12, 1940); Australian patent 105,592 (Nov. 3, 1938); British patent 497,960 (Dec. 30, 1938).—*C. A.* 33, 2715, 5185.

When treating any one particular cellulosic material, it is advantageous, if not essential, to utilize a bacterial culture which is specifically adapted for the disintegration of the incrustants of the fiber to be treated and thus it is advisable to prepare a special culture for any particular material. A description is given of the preparation of a special bacterial culture for bagasse. The bagasse is baled, the bales are impregnated with the liquor containing the suitable bacterial culture and containing up to about 5% of sugar-containing nutrient for the bacteria and are stacked on a sterilized floor, with the interstices between the bales packed with loose impregnated straw. The fermentation is allowed to proceed in the presence of a limited amount of air for from 14 days to 4 months, according to the cellulose content which is finally desired but is arrested before the bacteria attack the cellulosic fibers. At the end of the fermentation, the external layer (1 to 2 inches in thickness) is removed for treatment with the succeeding batch of material and the remainder of the material is washed in a tank or washing machine for 20 minutes. The washed material is baled and air dried to a water content of 15–20%. The bagasse in this condition may be stored for years without further change. The resultant pulp is strong and may be used, without further chemical treatment, for board. *See also* No. 89.

334. ROBERTS, S. G. An insulating lumber from bagasse. *Compressed Air Mag.* 27, 291–2 (1922).

335. ROMMEL, GEORGE M. Cellulose resources. II. Cellulose from field crops. III. Cost of field crops for cellulose. *Ind. Eng. Chem.* 20, 587–91, 716–9 (1928).—*C. A.* 22, 3774.

These articles are abstracts from the book noted in the following abstract.

336. ROMMEL, GEORGE M. Farm products in industry. New York, Henkle Co., 1928. 318 pp.

Sugar cane is discussed on pages 203–9. The first part of the section is devoted to the introduction and value of P. O. J. (Proef-station Oost Java) cane. About 500 pounds of wet bagasse are produced for each ton of cane taken to the mill; this carries from 45 to 54% of water. It is estimated that, in Louisiana in 1928, 750,000 tons of wet or 375,000 tons of dry bagasse will be produced. The price paid by the Celotex Company in the past for bagasse is equivalent to about 25 cents for each ton of sugar cane produced. A yield of 10 tons of cane per acre would thus net the grower about $2.50 per acre for bagasse. No details are given of the manufacturing process for the transformation of bagasse into board.

337. ROTHE, JULIUS A. Improvement in the manufacture of paper-pulp from straw, etc. U. S. patent 121,130 (Nov. 21, 1871).

Sugar cane and like fibrous materials are boiled with water or a solution of sodium carbonate and piled into heaps, ammonium hydroxide being sprinkled upon successive layers. The fermentation process was very rapid and the separation of the siliceous matter from the fibers was greatly facilitated.

338. ROUTLEDGE, THOMAS. Improvement in processes of treating fibrous substances for paper-stock. U. S. patent 137,484 (April 1, 1873).

Bagasse and similar materials are treated with an alkaline steep liquor at ordinary temperatures for 24 to 36 hours and then fermented for 36 to 70 hours using a portion of the ferment resulting from a previous operation (in the first instance the ferment is obtained by allowing the alkali-treated material to stand until fermentation occurs naturally). The best results with the alkaline steep are obtained at 110–120° for 10–12 hours or at 160–180° F. for 8–10 hours. The amount of lime to be used with bagasse may be 15–25% of the fiber treated.

339. ROZA, JOAQUIN J. DE LA, SR. Bagasse cellulose. *Mem. asoc. tecnicosazuc. Cuba* 11, 349–55 (1937).—*C. A.* 32, 8820.

Prepared bagasse is continuously treated in a first stage with sulfur dioxide and in a second stage with sodium hydroxide. After bleaching with chlorine, the product is 99.5% alpha-cellulose.

340. ROZA, JOAQUIN J. DE LA, SR. Purified cellulose for explosives obtained from sugar-cane bagasse. *Mem. 14th conf. anual, Asoc. tec. azucar Cuba* 1940, 331–2.—*B. I. P. C.* 13, 4; *C. A.* 35, 5317.

Roza's patented process gives a product containing 99% alpha-cellulose, which is more easily nitrated, washed, and dehydrated than linters.

341. ROZA, JOAQUIN J. DE LA, SR. Sugar-cane alpha-cellulose. *Fourth Ann. Conference Assoc. Sugar Tech. of Cuba*, 1930.—*T. S.* 93, 85, 145; *C. A.* 25, 3161.

The cellulose plant installed at Central Tuinucu, Cuba, for producing basic raw material for a number of valuable products is considered and the requirements of commercial alpha-cellulose as to ash, color, etc., are discussed. The difficulties encountered in developing the equipment and the process—digesting, pumping, foaming, draining, screening, corrosion, bleaching—are enumerated. It was found indispensable to keep fine bagacillo away and often a change in the direction of the wind would render necessary extreme measures. Cuban alpha-cellulose is considered a proved competitor of purified cotton linters and represents a great help to the sugar industry.

342. ROZA, JOAQUIN J. DE LA, SR. Method of producing fibrous thread. U. S. patent 1,681,223 (Aug. 21, 1928).

A method of producing textile fibers from sugar cane or bagasse includes the steps of fermenting the fiber to initiate the generation of acids, retting the fibrous portion of the cane with running water at about 30° C., and treating the material with a dilute alkaline bath.

343. ROZA, JOAQUIN J. DE LA, SR. Production of strong white pulp. U. S. patent 1,721,376 (July 16, 1929).—*T. S.* 91, 45.

Bagasse, suspended in hot water, is treated with 0.5–10% of sulfur (based on the bone-dry weight of the material) and steam is injected until the temperature reaches 130° C., at which point the air is removed; steam is further introduced until the temperature is 160–173° C. and the mixture is held at that temperature for from 20 minutes to 3 hours, depending upon the character of the bagasse used. After washing in the digester with water or a slightly alkaline solution, a dilute alkali (sodium or potassium hydroxide; 20 to 100 grams of sodium per liter of water) is added and the material is heated at 160–173° C. for 2.5 to 5 hours. The resulting pulp is snow white without the use of any bleach. The paper from this pulp has the strength characteristics of kraft paper.

344. ROZA, JOAQUIN J. DE LA, SR. Fibrous material from sugar cane. U. S. patent 1,782,869 (Nov. 25, 1930).—*T. S.* 92, 267.

Bagasse is first washed with water at about 90° C. for 0.5 hour; it is then heated in a digester with water at about 160° C. and a pressure of about 6.35 kg. per sq. cm. for a period up to 3–4 hours, depending upon the quality of the bagasse; this operation is carried out in the substantial absence of air. The product is then washed with water (with agitation). The subsequent digestion will require less chemicals and the yield will be increased.

345. ROZA, JOAQUIN J. DE LA, SR. Apparatus for removing carbon and the like from cellulose. U. S. patent 1,817,973 (Aug. 11, 1931).

Because of fires in sugar cane fields, bagasse may be mixed with carbon and carbonaceous material, separation of which is difficult. It is proposed to mix this material with a large proportion of water and a small proportion of a hydrocarbon

liquid, such as kerosene or coal oil, and permit the mixture to flow slowly through a duct or channel divided at its outlet end with a skimming weir or dam and with an outlet opening near the bottom. The oil rises to the top and carries with it the carbon and the like to form a scum, whereas the cellulose settles to the bottom of the duct. An apparatus is described and illustrated.

346. Roza, Joaquin J. de la, Sr. Manufacture of cellulose from fibrous material such as sugar-cane fiber. U. S. patent 1,825,655 (Oct. 6, 1931); British patent 347,297 (Dec. 30, 1929).—*T. S.* 94, 321; *C. A.* 27, 599.

The raw material is impregnated with a solution containing 2–5% of sulfur dioxide at atmospheric pressure for a period of a few minutes to an hour at a maximum temperature of 80° C.; or a solution containing 0.5% of sulfur dioxide may be used for 6 hours or more. The material thus treated may be stored for an indefinite period of time. After washing thoroughly with hot water, the material is treated with 18–25% of an alkali, such as potassium or sodium hydroxide, sulfate liquor, sodium monosulfite, or calcium or other bisulfite. The temperature of 140-170° is maintained for 1 to 12 hours or more, depending upon the reagent used.

347. Roza, Joaquin J. de la, Sr. Production of celluose from sugar cane fiber. U. S. patent 1,862,177 (June 7, 1932); British patent 322,763 (June 30, 1928); Canadian patent 286,198 (Jan. 8, 1929); French patent 688,311 (Jan. 15, 1930).—*T. S.* 92, 178, 291; 95, 233.

The process consists in the treatment of sugar cane fiber with a dilute aqueous sulfurous acid solution, washing with hot water, and treatment with a hot aqueous alkaline solution. A 4–5% solution of sulfurous acid (based on the bone-dry weight of the fiber) is used at atmospheric pressure for a few minutes; this is stated to remove the sugars, pentosans, coloring matter, and the like; it also destroys the various fungi and other growths, so that the treated material may be stored in the open or in bales. After the washing with hot water, the material is treated with 15–20% of alkali (potassium or sodium hydroxide) and is heated rapidly to 140–170° C. for 1–2 hours. Finally, the product is washed with water and bleached. It is stated that the alkali treatment may be carried out at a temperature below 100° C. and at atmospheric pressure, after which the material is treated in a rod mill, ball mill, Jordan, or similar refiner.

348. Roza, Joaquin J. de la, Sr. Method of manufacturing cellulose. U. S. patent 1,864,985 (June 28, 1932).

This patent is similar to U. S. patent 1,862,177 (No. 347), except that a weaker sulfurous solution is used and the intermediate washing is omitted. About 1% sulfurous acid is used (based on the bone-dry weight of the sugar cane fiber), without any base, at a temperature of 120–130° C. for a few minutes. In the second step, about 18–25% alkali (such as potassium or sodium hydroxide) is used at a temperature of 140–170° C. for a period of 1–2 hours.

349. Roza, Joaquin J. de la, Sr. Method of producing alphacellulose. U. S. patent 1,918,250 (July 18, 1933).

The method includes a first treatment of the fiber with a mixture of water and sulfur dioxide at a medium to high density (e. g., 10%), a temperature of 98–120° C. (preferably about 110° C.), and a pressure substantially higher than atmospheric for a comparatively short period; after washing with hot water, the material is treated with an aqueous alkaline solution of medium concentration at a medium to high density, at a temperature above 100° C. (preferably not higher than 140° C.), and at a pressure substantially greater than atmospheric.

350. Roza, Joaquin J. de la, Sr. Method of manufacturing cellulose. U. S. patent 1,931,575 (Oct 24, 1933).—*T. S.* 99, 22.

The process involves the following steps: a first treatment with an acid solution (from 2 to 6 pounds of sulfur dioxide per 100 pounds of bone-dry fiber) at atmospheric pressure and temperature for a period up to several months; a second treatment in a closed vessel with 12 to 25–30 pounds of sulfur dioxide per 100 pounds of pulp at a temperature not to exceed 110° C. (good results are obtained at 98° C.) at a consistency of 50% or higher for a period of a few minutes up to 3–4 hours, depending upon the quality of pulp desired; after washing, the pulp is treated with an alkali (equivalent to 2–14% of sodium hydroxide) at atmospheric pressure and below 100° C. for a comparatively short period, followed by a treatment at high density and elevated pressure and temperature for a comparatively short period—e. g., at 140–160° C. for 4–6 hours.

351. De la Roza Corporation. Digesting cellulosic materials. British patent 457,524 (November 27, 1936).—*C. A.* 31, 2819.

Pulp is obtained from bagasse, corn stalks, cotton linters, cotton stalks, bamboo, straw, jute, hemp, fir, oak, poplar, etc., by compacting to remove substantially all air, as by forcing liquid, gas, or powder therethrough, and feeding the compacted material to the digestion zone, formation of sulfuric acid from sulfurous acid being thus prevented. Apparatus is described.

351A. Newsprint from bagasse made at Madison; de la Roza plans three newsprint mills. *Paper Mill News* 74, no. 34, 5 (Aug. 25, 1951).

A news item states that the Forest Products Laboratory has made newsprint from bagasse (apparently by a process developed by J. de la Roza; no details are given) which is "stronger and whiter" than the ordinary variety. The paper had "physical properties approaching closely those of standard newsprint made from wood." The item further states that de la Roza plans to build a $15,000,000 mill at Clewiston, Fla., to make newsprint from bagasse; the paper would cost no more than that made from wood.

352. Rue, John D., Wells, Sidney D., and Rawling, Francis G. Production of fibrous pulp from vegetable material. U. S. patent 1,859,848 (May 24, 1932).

The patent covers the use of sodium carbonate and sodium sulfite in the manufacture of pulp from bagasse, straw, and other fibrous materials. Variation in the ratio of sulfite and carbonate may be used, but the amount of carbonate should be at least 20% of the sulfite. Sufficient carbonate is desirable to neutralize the organic acids formed by the hydrolytic action of the sulfite. The resulting pulps contain 65–80% cellulose, and about 20% each of lignin and pentosans; they are suitable for containers for eggs and other food products. Details are given of the application of the process to straw.

353. Ruegg, C. G. The shredded cane at Madison, Wisconsin. *Louisiana Planter* 49, 312 (1912).—*C. A.* 7, 287. (Cf. *Ibid.* 45, 291 (1910).—*C. A.* 5, 389.)

The fiber from the Simmons process, representing 55%, is baled separately from the pith, which represents 45%. The separate baling is done so that different grades of paper can be made. Storage of the shredded cane does not seem to affect the sugar content. It takes 3.5 tons of cane to make one ton of shredded cane.

354. Salvatore, E. Utilization of bagasse for the extraction of cellulose by the Pomilio process in the Philippine Islands. *Atti X° congr. intern. chim.* 4, 173–80 (1939).—*C. A.* 34, 2167.

After a general discussion of the cellulose content of bagasse and of its availability, the author describes briefly a manufacturing plant now in construction on Negro Island, P. I., which will produce alpha-cellulose from bagasse by the Pomilio process.

355. Sammet, Charles F., and Merrill, Jason L. Process for treating fiber-yielding materials. U. S. patent 1,016,178 (Jan. 30, 1912).

The raw material, cut into pieces of appropriate size, is subjected to the action of gases or vapors—e. g., sulfur dioxide, ammonia, and steam—under any suitable pressure, preferably from 25 to 125 pounds, and at any suitable temperature, preferably from 125 to 160° C. The concentrations of the chemicals in the digester are regulated and maintained by the quantities introduced, either continually or intermittently. The vapors condense within the digester and, containing part or all of the products from the chemical action on the material treated, may be removed therefrom either continuously or at intervals by the aid of a suitable relief valve attached to the digester.

356. Scott, Douglas E. Process of isolating fiber from bagasse. U. S. patent 1,399,891 (Dec. 31, 1921).—*C. A.* 16, 839.

This invention is a process of treating bagasse (the residue from the crushing of sugar cane) for the purpose of preparing therefrom a clean fiber suitable for paper-making or other purposes. The bagasse is preferably but not necessarily subjected to a supplemental shredding, or shredding and crushing, operation, using any of the standard shredding devices. The moist product is then charged into an apparatus designed and adapted to disintegrate further and minutely the material

into its structural elements in the presence of a relatively large proportion of water (25 to 50 times the weight of the bagasse). The apparatus must be equipped with a suitable screening device adapted to wet screening and provided with screen of a mesh that is capable of effecting a reasonably perfect separation of the pith and fiber. The ordinary beater, equipped with a washer, may be adapted to the process, the usual fine mesh wire of the washing cylinder being replaced with the relatively coarse mesh mentioned about (about 12 mesh is satisfactory). If the bagasse has been shredded, about one hour in the beater will effect the separation. The effect of the beating operation is to (1) detach the particles of pith from the fibrous stock and distintegrate the latter; (2) wash the pithy particles through the washing cylinder, thus eliminating them so far as the paper-making operation is concerned; and (3) eliminate a large amount of the dirt and insoluble matter which could not be removed in the course of any of the subsequent processes of paper making.

357. Scott, Walter. Industrial utilization of sugar-cane by-products. Report Caribbean Commission Central Secretar., 1950. 121 p. *C. A.* 45, 5955.

A technological and commercial survey was made of all known processes in various countries for the manufacture of products from bagasse and molasses.

358. Scurr, A. T. Bagasse as a raw material for manufactured goods. *Proc. S. African Sugar Assoc., 4th Ann. Cong.* 1926, 34–5.—*C. A.* 21, 187.

Attention is called to the possible use of bagasse by conversion into an organic nitrogen fertilizer, and to the manufacture of Celotex. In the discussion, the use of bagasse for making mulching paper is brought out.

359. Seidel, George M. The Vazcane process. *Ind. Eng. Chem.* 22, 765–8 (1930); *Pulp Paper Mag. Canada* 30, 413–5, 419 (1930); *Wochbl. Papierfabr.* 61, 1380–2 (1930).—*T. S.* 92, 143; *C. A.* 24, 4180.

The Vazcane process (invented by E. A. Vazquez; Nos. 417–418) is suitable for the simultaneous production of sugar and pulp suitable for board directly from sugar cane as raw material. The cane is introduced into a hopper over an artificial silicon carbide roll, 20 inches in diameter by 42-inch face. This is driven by 100-h. p., 1,200-r. p. m. motor. A chain crowding conveyor presses the cane against the stone, which revolves in a bath of pulp and juice and is kept clean by a shower of returned juice to maintain a consistency of 4%. The power consumption is 1.83 kw. per ton of cane per 24 hours or, on the basis of 10% fiber content, 18.3 kw. per ton of fiber per 24 hours. The mixture of pulp and juice is pumped to a continuous diffuser, which consists of a 12-stage countercurrent washing system. The pulp is given a light beating to remove the few slivers which pass the stone. Two percent of rosin size is added, which is precipitated by copper and aluminum sulfates; 0.5% of copper sulfate (as the pentahydrate) is used, with sufficient alum to maintain a pH of 5.8 to 6.2. The precipitated copper resinate is an effective preventative against fungi. The pulp is then dumped to a stock chest, pumped to a constant-head box, and then passed to the board machine. The Vazcane fiber is so free that the machine is run in such a manner that all the formation is on one cylinder. The press part consists of five presses—a small standard press part. A mat approximately one inch thick is pressed to 0.5 inch, 65% moisture. The amount of pressure applied depends on the type of board being made. The insulating board made in this way is equal to the best on the market. Costs are discussed.

360. Sellegar, E. L. Bagasse. *Paper Makers' Mo. J.* 45, 101 (1907); *Paper Trade J.* 44, no. 1, 52 (1907).

361. Shaw, John K. Fiber board from bagasse. U. S. patent 1,457,285 (May 29, 1923); Canadian patents 212,129 and 212,130 (May 31, 1921); *Paper Trade J.* 74, no. 14, 51.

The bagasse is digested with 2–10% of sodium hydroxide (based on the bone-dry weight of fiber) for 1–4 hours at atmospheric pressure and a temperature of 150–212° F. The treatment is limited to that action which loosens the outer encasing of the fibers so that, when the latter are passed through a beating engine and a sieving apparatus, the casings may be readily and mechanically separated from the fibers themselves. By this method, the yield is 65–80% of the original material, principally because all of the pith is retained. The resulting fibers are strong and flexible and are rough on the exterior, so that they are capable of interlocking or entangling with each other. These fibers form a board of great tensile and breaking strength, which may be used as a substitute for lumber. Other fibers may be added to give certain properties to the board.

362. SHAW, JOHN K. Redwood bark (and bagasse, etc.) wall board. U. S. patent 1,468,036 (Sept. 18, 1923).—*T. S.* 79, 220.

In the manufacture of wallboard from redwood bark fibers, bagasse fibers may be used to form one of the layers.

363. SHAW, JOHN K. Process of obtaining fibers from bagasse. U. S. patent 1,501,924 (July 22, 1924).—*T. S.* 80, 2; *C. A.* 18, 2963.

A process for treating bagasse fibers consists in cooking the fibers with their natural pith sufficiently to loosen the incrusting casings but insufficiently to dissolve a substantial portion of the pith, subjecting the fibers to a beating action, separating a portion of the long fibers from the short fibers, subjecting a portion of the long fibers to a second cooking action to produce a paper-making pulp and a solution of the pith, recovering the short fibers, and forming them into a board, which is treated with the pith solution.

364. SHAW, JOHN K. Bagasse fiber and process of producing same. U. S. patent 1,501,925 (July 22, 1924).—*T. S.* 80, 2; *C. A.* 18, 2963.

The process consists in heating the raw bagasse fibers with from 2 to 10% of sodium hydroxide (on the bone-dry weight of the bagasse) for from 1 to 3 hours at a temperature of from 150° to 212° F. The pith is not recovered from the fiber. Under these conditions, the yield represents 65 to 80% of the original material. The product may be formed into heat-insulating boards which, when compressed, have a tensile strength of over 17,000 pounds. Mention is also made of the precipitation of the original binding and encasing material from the alkali solution onto the individual fibers to render them water repellent.

365. SHAW, JOHN K. Plaster board. U. S. patent 1,503,211 (July 29, 1924).—*T. S.* 81, 235.

This patent relates to a plaster board having hard and soft portions and composed of interlaced fibers. It is preferred to use long bagasse fibers, but fibers of any usual length may be employed. The method employed provides for positively interlacing the fibers in the body of the sheet and also in varying the kind, size, and class of the fibers in different portions of the sheet. A hardening and strengthening solution for boards of this type is formed by boiling bagasse fibers in a relatively weak sodium hydroxide solution. The soluble material, removed by the alkali, is readily precipitated on the fibers of the board by alum. The advantages of employing bagasse or pith-carrying fibers are discussed.

366. SHAW, JOHN K. Sound-deadening fiber board. U. S. patent 1,503,605 (Aug. 5, 1924).—*T. S.* 81, 235.

A fiberboard is composed of different layers of fibers, all of which are interlaced throughout the body portion of the board. These layers may consist of bagasse fibers, wood fibers, hair, etc.

367. SHAW, JOHN K. Fiber board and process and apparatus for making same. U. S. patent 1,532,083 (March 31, 1925).—*T. S.* 82, 252.

This invention relates to a process and an apparatus for interlacing fibers preparatory to making fiber boards. The process consists in directing the flow of stock practically at right angles to the wire. The two outside layers are formed on two different wires, which are subsequently brought together; the inner layer (or layers) is formed by leading a different kind of stock onto the same wires, but at a point further from that at which the outer layers are deposited.

368. SHAW, JOHN K. Board composed of interlaced fibers. U. S. patent 1,532,084 (March 31, 1925).—*T. S.* 82, 252.

This patent is related to U. S. patent 1,457,285 (No. 361); *see also* U. S. patent 1,544,042 (No. 369). It covers a fiber board composed of different layers of different kinds of fibers interlaced with each other to form a mass devoid of laminae; the fibers of the outer layer may be of a higher quality than those of the inner portion of the board.

369. SHAW, JOHN K. Fiber board of felted interlaced fibers. U. S. patent 1,544,042 (June 30, 1925).—*T. S.* 82, 39.

This is related to U. S. patents 1,457,285 (No. 361) and 1,532,084 (No. 368); the present board is composed of different layers of interlaced pith-carrying fibers which produce not only a true felting or entangling action but also high heat-insulating qualities because the pith particles are composed largely of closed air cells. An apparatus for forming such a board is described. The product is stated

to have a tensile strength of over 16,000 pounds and a transverse breaking strength of 285 pounds.

370. Shaw, John K. Process of making board from bagasse and analogous fibers. U. S. patent 1,572,565 (Feb. 9, 1926).—*C. A.* 20, 1310; *T. S.* 84, 56.

According to U. S. patent 1,501,925 (No. 364), bagasse may be cooked with a 2% sodium hydroxide solution for 1–3 hours at atmospheric pressure and a temperature of 150° to 212° F.; this gives a weight of pith and fibers from the bagasse equal to from 65 to 80% of the bone-dry weight of the original material. In the present invention, it is stated that other chemicals, such as sulfates, may be used in various concentrations, provided these solutions are used for a time sufficient to loosen the encrusting casing, but insufficient to dissolve any substantial portion of the pith (such a product would not be suitable for papermaking). Definite concentrations are not given, but it is stated that from 1 to 3 hours are sufficient for wallboard pulp. In an example, an open container is used, the time is 1.5 hours, and the beating time is about 45 minutes. The loss of original fiber is not over 15%. It is claimed that wallboard from this pulp has a tensile strength of more than 10 times that of other boards made from similar fibers according to the prior processes.

371. Shikata, Masuzo, Tachi, Isamu, and Urano, Nobukiyo. Digestion of bagasse by the calcium sulfite process. *J. Agr. Chem. Soc. Japan* 18, 1087–91 (1942).—*C. A.* 45, 6839.

Uniform heating was difficult because of the voluminous form of the bagasse. Blackening of the raw pulp resulted when the digestion mixture contained 4.5 to 6.5% total sulfur dioxide and 1% calcium oxide. Higher digestion temperatures were accompanied by blackening of the pulp. The best pulp was obtained when seven times as much digestion solution (5% total sulfur dioxide and 1% calcium oxide) was added to the bagasse and the mixture was heated three hours at 110 to 120°/5 atmospheres. The nonbleached pulp contained 87.5% cellulose, 73% alpha-cellulose, 9.2% lignin, 14.9% pentosans, and 1.4% ash; the yield was 51%. Experiments with magnesium sulfite were successful when the magnesium oxide content of the digestion liquor was as high as 2.5%.

372. Shinra, Koichiro, and Tze, Youn Pen. The nitric acid pulping process. IV. Comparison of amount of nitric acid consumed in cooking various materials. *J. Soc. Chem. Ind. Japan* 46, 293–7 (1943).—*C. A.* 43, 1973.

Among the materials studied was bagasse. The abstract [original not available] does not give data for the nitric acid consumption.

372A. Siddiqui, S., Sarin, K. K., Varma, J. P., and Dayal, P. Roofing boards. Indian patent 41,878 (May 2, 1951).—*C. A.* 45, 8736.

Short-sized fibrous material (coconut fibers, sisal, jute, or flax) is mixed with bagasse pulp and water to form a suspension. The water is allowed to drain off and the mass is pressed into board. The proportion of pulp and fiber is preferably 75 to 25 by weight. Bagasse is obtained by cooking the material with sodium hydroxide solution and grinding the cooked bagasse in beaters.

373. Simoda, Isao, and Kono, Masao. Manufacture of cellulose pulp by the nitric acid process. XV. Suitability of the nitric acid process for Gramineae. *Cellulose Ind.* (Tokyo) 17, 76–7; *Abstracts* (in German) 13–5 (1941).—*C. A.* 35, 5695.

Cellulose was prepared from rice straw, wheat straw, bamboo, bagasse, and Manchurian reed by triple digestion with nitric acid and sodium hydroxide. In the first step, 100 grams of the raw material were boiled with 20 grams of sodium hydroxide and sufficient water to give a concentration of alkali of 2%; in the second step, the material was boiled with 10 times its volume of a mixture of 3% nitric acid and 1% sulfuric acid for one hour; finally, the product was boiled for one hour with 10 times its volume of 2% sodium hydroxide. The material was then bleached. The yield from bagasse was 27.9%; the pulp contained 88.2% cellulose, 9.27% pentosans, 0.6% ash, 1.03% benzene-alcohol extract, and had a copper number of 1.83. The polymerization degree was 590.

374. Singh, S. Chattar. The manufacture of insulating and pressed boards, wrapping paper, and straw board from bagasse. *J. Sci. & Ind. Research* (*India*) 3, 399–403 (1945).—*C. A.* 40, 4544.

The application of the Asplund defibrating process to bagasse has been investigated as a method for the preparation of pulp for insulation and wall board.

The resulting product compares favorably in strength, sound absorption coefficient, and resistance to moisture with similar foreign products. The yield is 60 to 80% of air-dry bagasse (10% moisture). Satisfactory moisture-proofing was obtained with 3 to 4% rosin and sufficient alum to give a pH of 4.5 to 5.5. Still better results were obtained with 2 to 3% of an emulsion of 10 parts of wax, 1 part of oleic acid, and 0.15 part of 25% ammonium hydroxide, precipitated with a sufficient quantity of alum. A mixture of rosin and wax sizing made the boards waterproof. Treatment with 10% of sodium pentachlorophenate and 4% of rosin, or with 5% of sodium pentachlorophenate, 5% of copper sulfate, and 4% of rosin protects the boards from attack by fungi and by insects such as termites. To render the boards fireproof they are impregnated with 20 to 25% of a mixture of 15 parts of ammonium sulfate, six parts of diammonium phosphate, two parts of trisodium phosphate, and two parts of borax, or with a mixture of eight parts of magnesium chloride, nine parts of diammonium phosphate, and three parts of ammonium hydroxide. The cost of the board is only about 57% of that of imported Celotex. The manufacture of wrapping paper and of strawboard is technically feasible but not promising economically.

375. Smyser, Frederic H. Cellulose composition and process of making molded products therefrom. U. S. patent 1,792,254 (Feb. 10, 1931); British patent 360,637 (Oct. 22, 1930).—*T. S.* 97, 260.

Six pounds of sawdust (or bagasse), 2 pounds of sodium hydroxide, and 1 gallon of water are treated with steam in a digester at about 160 pounds pressure for 3–4 hours, removed from the digester, and treated with a solution of 3.5 pounds of concentrated sulfuric acid in 3–4 gallons of water. The mass is filtered and washed until the filtrate is neutral. After drying in the air at about 80° C., about 10% (in the case of bagasse) of lime are added and the mixture is molded at 150–160° C. and 3000 pounds per square inch; the molded article may be removed from the mold while hot without distortion.

376. Snell, Ralph M. The story of papermaking in the United States. *Superior Facts*, 5, no. 12, 7–10 (June 1932).

A number of unsuccessful attempts to make paper from bagasse is listed. Successful attempts include the Olaa Sugar Company of Hawaii (*see* articles by Mason, No. 244 and No. 245) and the Celotex Company (a letter from C. G. Muench gives some of the history of this company; a quotation from an article in the Proceedings of the Louisiana Engineering Society gives some of the technical details, No. 257).

377. Sugar cane bagasse good for paper and board manufacture. *Southern Pulp Paper Manuf.* 13, no. 6, 40, 42 (1950).—*B. I. P. C.* 20, 774.

Brief reference is made to the suitability of bagasse as a source of pulp and paper, particularly in connection with alcohol plants. A contract for a new bagasse pulp mill near a large sugar factory in São Paolo, Brazil has just been signed with Celdecor Africa (Pty.) Ltd., Benoni, South Africa. The plant will follow the usual lines of the Celdecor-Pomilio process for fine paper pulp. The pulp will be bleached in a continuous Celdecor-Kamyr plant.

378. Sugar Cane By-Products Co. Turning waste into wealth. 1918. 28 pp.

379. Sugar cane for paper. *Paper Making* 34, 379 (1915).

380. Sugar-cane paper. *Papier-Ztg.* 36, 2221-2 (1911).—*C. A.* 5, 3621.

A discussion of the chance which paper made from bagasse has of commercially competing with wood-pulp paper.

381. Sugar cane yields new insulating material. *Raw Material* 4, 445 (1921).

382. Sutermeister, Edwin. Chemistry of pulp and paper making. 3rd ed. New York, Wiley, 1941.

Bagasse is briefly discussed on pages 43, 86 and 250. The pith cells of bagasse are one of the chief obstacles to the use of this material in papermaking, since fiber containing them imparts hardness and rattle to the paper which are undesirable in many products. Bagasse is easily pulped by the alkaline processes and the pulp gives a good color with less than 10% of bleach. At least four attempts to use bagasse on a commercial basis have resulted in failure, chiefly because of the poor quality of the resulting papers. A review is given of the work of Lynch and Goss and of Aronovsky and Lynch on the pulping of bagasse with nitric acid. No conclusions are given regarding the process, although its disadvantages are outlined.

383. SWEENEY, O. R. The future of chemistry in agriculture. *Agr. Eng.* 12, 381–4 (1931).—*C. A.* 27, 2747.

A discussion of the possibilities in the utilization of agricultural wastes, such as cornstalks and bagasse, for the manufacture of wallboard, paper, chemicals, etc., is given.

384. SYMES, EARL L. Vazcane process: fiber boards production from bagasse. *Intern. Sugar J.* 31, 645–9 (1929).—*C. A.* 24, 2323.

Although there have been many successful attempts to manufacture fiber board and paper from cane bagasse, the Vazcane process is the first to combine fiber board machinery and sugar house equipment. The process consists in separating cane into very small particles of fiber by an abrasive roll. A solvent bath is used in connection with the crusher, so that by a diffusion process in conjunction with thorough comminution, a sucrose extraction of over 99% is obtained. A small factory was equipped for the process, with a capacity of 5 tons of fiber board, grinding 50 tons of cane per day. The abrasive roll was 20 inches in circumference and 42 inches long, and was constructed of medium grit carborundum with bakelite as a binder. This roll had a capacity of 2.5 short tons per hour and a factory grinding 1000 tons of cane per day would require four stones of the commercial size, 42 inches in diameter and 60 inches long. It is pointed out that the value of the sugar from an acre under the present prices would be $90.00, whereas the fiber board per acre under the Vazcane process would represent a value of $120.00 at the conservative estimate of $20.00 per thousand feet.

385. TADOKORO, TETSUTARO, and ITO, KEIZO. Chemical studies of bagasse pulp. I. *J. Agr. Chem. Soc. Japan* 17, 291–4 (1941).—*C. A.* 45, 4039.

Samples of bagasse, stored less than one year and about three years, respectively, were pulverized and sieved with a 80-mesh sieve. The former contained 91% and the latter 87% of material retained on the sieve. Some of the organic constituents were lost during storage, since the one-year sample contained less ash and more material soluble in water, ethyl alcohol, ether, and a mixture of ethyl alcohol and benzene than did the three-year sample. Preliminary digestion of the two samples with alkali showed no consistent differences in free alkali, pulp, yield, or the composition of the pulp obtained.

386. TADOKORO, TETSUTARO, KANEKO, TADASHI, and ITO, KEIZO. Bagasse as a source of pulp. III. *J. Agr. Chem. Soc. Japan* 17, 408-10 (1941).—*C. A.* 41, 4917.

The analysis of bagasse fibers showed little difference from that of *Hemerocallis* (roof thatching material in northern Japan) fibers, but as compared with year-old *Crotalaria sesban* (a tropical deciduous tree) are richer in pentosans and material soluble in 1% sodium hydroxide. Unbleached bagasse pulp, as compared with pulps from Madras hemp, pine, plum, and cypress trees, are extremely rich in ash and also rich in beta- and gamma-cellulose and lignin, the characteristics being shared by the pulp from Madras hemp. Hence, in spite of high total cellulose content, bagasse pulp is relatively poor in alpha-cellulose. Bleached bagasse pulp, when compared with bleached *Hemerocallis*, soybean stalk, and Canadian pulps, are almost as good as the Canadian pulp because of the improvement of the bleaching method with sodium hydroxide. The soybean stalk pulp, however, is still too rich in ash and lignin.

387. TADOKORO, TETSUTARO, and NISHIDA, MASAO. Bagasse as a source of pulp. II. *J. Agr. Chem. Soc. Japan*, 17, 404–7 (1941).—*C. A.* 41, 4917.

Analysis of sugar cane and barley, representing the starch-seed plants, and of soybean and flax, representing the oil-seed plants, shows that the fibers of the first group are richer in pentosans and acetyl groups but relatively poor in hexosans. The first group contained more cellulose, although the difference was often slight. Viscose made from bagasse pulp and mixed with a 20% fish protein-urea solution compared well with that made from soda pulp from cryptometia (pine) mixed with 30% fish protein-urea solution (tensile strength 6.90 and 3.40 grams; elongation 19.6 and 24%; denier 5.4 and 4.2, respectively).

388. TADOKORO, TETSUTARO, and NISHIDA, MASAO. Chemical studies of bagasse pulp. VI. *J. Agr. Chem. Soc. Japan* 17, 776-8 (1941).—*C. A.* 45, 4039.

The optimum conditions for digesting with calcium sulfite were about six hours at 130°. Chlorination, treatment with sodium hydroxide, and bleaching were necessary to produce fairly good pulp with a high viscosity and a low copper number.

389. TADOKORO, TETSUTARO, and NISHIDA, MASAO. Chemical studies of bagasse pulp. VII. *J. Agr. Chem. Soc. Japan* 17, 1064-6 (1941).—*C. A.* 45, 4039.

Bagasse pulp of superior quality (85% alpha-cellulose, copper numbers of 0.34 to 0.67, and the highest viscosity of cellulose nitrate solutions) was obtained by pulping with a solution containing 3.4% total sulfur dioxide, 2.2% free sulfur dioxide, and 1.2% combined sulfur dioxide. The finer portions of the bagasse should be removed in order to obtain rayon pulp.

390. TADOKORO, TETSUTARO, and NISHIDA, MASAO. Chemical studies of bagasse pulp. VIII. *J. Agr. Chem. Soc. Japan* 18, 166-8 (1942).—*C. A.* 45, 4039.

A comparison was made of the conditions suitable for obtaining superior pulp from bagasse, pine wood, and deciduous trees. In the calcium sulfite method, the optimum conditions for bagasse (cf. part VII) were lower by 0.5% in the concentration of total sulfur dioxide, lower by 5° in the highest temperature, and shorter by 20 to 30% in the duration, than for the trees. The optimum conditions in the sodium hydroxide method for pulping bagasse were 2.8% sodium hydroxide, 170°, and three hours, as compared with 4-6.5% sodium hydroxide, 170°, and 4.5 to 8 hours for the various trees.

391. TADOKORO, TETSUTARO, and NISHIDA, MASAO. Chemical studies of bagasse pulp. IX. *J. Agr. Chem. Soc. Japan* 18, 169-74 (1942).—*C. A.* 45, 4039.

Bagasse can be grouped with cornstalks (designated sugary plants) in contrast with plants containing fats (e. g., soybean stalks). In the sugary plants, as well as in deciduous trees, the pentosans are considered to be in combination with cellulose and assist in maintaining the degree of polymerization; if the pentosans are removed, the pulp is purer but produces less viscous cellulose nitrate solutions because of the decrease in the degree of polymerization.

392. TADOKORO, TETSUTARO, and NISHIDA, MASAO. Chemical studies of bagasse pulp. X. *J. Agr. Chem. Soc. Japan* 18, 669–672 (1942).—*C. A.* 45, 4040.

The pulp of herbs (including bagasse pulp) contained more carboxyl groups (uronic acid) than pulp from wood; the ratio was 0.7–0.9 to 0.3–0.56. The acetyl content of herb pulp was higher than that of wood pulp: 2.15 to 2.95% as compared with 1.28 to 1.85%. The ratio of pentosans to acetyl of various pulps fell into the range 2.9 to 3.65 for all herb pulps tested.

393. TADOKORO, TETSUTARO, and NISHIDA, MASAO. Chemical studies of bagasse pulp. XI. *J. Agr. Chem. Soc. Japan* 18, 1117–18 (1942).—*C. A.* 45, 4040.

When the pentosans content of pulp was reduced by too rigorous purification, the resulting pulp contained less alpha-cellulose; the content of beta-cellulose increased and there was a decrease in the strength properties.

394. TADOKORO, TETSUTARO, NISHIDA, MASAO, and ITO, KEIZO. Bagasse as a source of pulp. IV. *J. Agr. Chem. Soc. Japan* 17, 476–8 (1941).—*C. A.* 41, 4918.

Bagasse pulp prepared by the magnesium bisulfite method excelled that prepared by the calcium bisulfite method or the soda process in that it has a high alpha-cellulose and low pentosans content; alpha-cellulose 85.3, 83.8, 79.6%; pentosans 8.80, 10.56, 22.05%, respectively. The yields were about the same in each case (34–35%). However, the soda method reduced the ash content about 33%. The method using sodium hydroxide with sodium sulfite or sodium sulfate (semichemical process) was less satisfactory than that using sodium hydroxide alone.

395. TADOKORO, TETSUTARO, NISHIDA, MASAO, and ITO, KEIZO. Chemical studies of bagasse pulp. V. *J. Agr. Chem. Soc. Japan* 17, 535–6 (1941).—*C. A.* 45, 4039.

Bagasse is more easily digested by the calcium sulfite method than are some tropical trees. Bagasse (20 grams) was pulped with 150 and 225 cc. of a solution containing 2.6% total sulfur dioxide at 150° and 4 atmospheres. The yield of the pulp (43 and 44%) and the quality of the pulp (alpha-cellulose, 83.5 and 87%) were better in the experiment with the larger volume.

396. TANAKA, SYOSUKE. Bagasse for the manufacture of Celotex (Artex). I. Changes in the constituents of a pile of bagasse. *J. Agr. Chem. Soc. Japan* 10, 1053–8 (1934).—*T. S.* 102, 87; *C. A.* 29, 1674.

When bagasse was piled in the open air for a year, the sugar and pectin and then the starch and pentosans were decomposed by fermentation. Under exceptional conditions, the crude fiber was easily decomposed, whereas the starch and pentosans were not changed. The decomposition of the bagasse was most rapid at the deepest places in the pile, which had the highest temperature.

397. TANAKA, SYOSUKE, and KORIYAMA, MUNEO. Manufacture of pulp from bagasse. I. Bagasse pulp by the soda process. *J. Agr. Chem. Soc. Japan* 14, 724–32 (1938).—*C. A.* 33, 2333; *B. I. P. C.* 9, 386.

A good pulp was prepared from bagasse by digesting with 18% sodium hydroxide under 2.5 to 6 atmospheres pressure for 3 hours. The yield of pulp from fresh bagasse was greater by 17% than that from old bagasse. Lignin was easily removed in both cases. The alpha-cellulose content in pulp from old bagasse was 83%, in that from fresh, 73%. Pentosan content was 26–31% in pulp from fresh bagasse and 7–10% in pulp from old. Though the bleaching of the pulp was more difficult than with the nitric acid process, the copper value was under 1.0.

398. TANAKA, SYOSUKE, and KORIYAMA, MUNEO. Manufacture of bagasse pulp. II. Digestion of bagasse with superheated water and bagasse pulp by soda process. *J. Agr. Chem. Soc. Japan* 15, 25–32 (1939). *C. A.* 34, 261.

When bagasse was heated with water under a pressure of 2 to 6 atmospheres for 2 hours, a very remarkable decrease in the pentosan content occurred. When it was heated with 20% sodium hydroxide under a pressure of 3 atmospheres, a superior quality of pulp was produced. The pentosan content of the pulp was less than 4% and the copper number was less than 1. There was no difference in the preparation of pulp between the fresh bagasse and that stored for 6 months.

399. TAUBE, GUSTAV. Process of manufacturing various products from cornstalks, sugar cane, and similar vegetable material. U. S. patent 1,857,985 (May 10, 1932).

The raw material, freed of leaves, is subjected to a vacuum to remove air, extracted with hot water for 8 to 12 hours, the extracted material is again subjected to a vacuum, and then pulped with 2% sodium hydroxide solution for two or three hours at two or three atmospheres. After washing to remove the excess alkali and the pith, the pulp is suitable for papermaking.

400. TEMPLE, G. Utilizing waste (Celotex). *Sci. Progress* 22, 475–80 (1928).—*C. A.* 22, 881.

401. TETTAMANZI, ANGELO. Cellulose of the sugar cane and its use in the paper industry. *Ric. sci. progr. tech. econ. naz.* (2) 8, I, 390–9 (1937).—*Chem. Zentr.* 1938, I, 1036.

The sugar cane residue from the extraction of sugar contains 51–52% cellulose. The various commercial pulping processes give good yields and the resulting pulp gives a paper with satisfactory strength properties.

402. THIELE, F. C. Manufacture of paper from sugar cane refuse. *Chem. Ztg.* 25, no. 27, 289–90 (1901).—*J. Soc. Chem. Ind.* 20, 495.

The author describes the process of papermaking from sugar cane refuse at a large mill in Texas. The raw material contains 82% of water, 16.5% of crude cellulose, 0.75% of carbohydrate, and 0.75% of mineral matter. The ash contains 82.8% silica, 6.6% ferric oxide, 3.7% alumina, 0.82% chlorine, 1.5% phosphoric acid, and 4.3% potash. The first step is a fermentation in heaps, during which the pectins are destroyed. The fermented material (moisture content not given) is digested in a rotary, the charge being 40,000 pounds of bagasse, 450 pounds of dry soda, and 200 pounds of dry quicklime, with sufficient water to dissolve the chemicals. The material is heated with direct steam at a pressure of 90 pounds per square inch for 4 hours. A brown paper, suitable for packing purposes, is manufactured; no size is added. The product may be bleached if it is given a pretreatment with sulfur dioxide.

403. THIEMANN, WILLIAM H. A. Spinning fibers from Gramineae low in silica. British patent 523,653 (July 19, 1940).—*C. A.* 35, 6467.

Bagasse or the like is preliminarily steeped in water, whereby separation of the parenchyma from the bast fibers is initiated. The wet material is subjected to a

mechanical treatment, such as squeezing or stamping, and is then retted under water containing a culture of retting bacteria. After 6 to 8 days, a portion of the retting water is run off for subsequent operations and the residual material is stamped or pressed. The bast fibers are washed, pressed, and dried.

404. THOMSEN, ALFRED M. Method of manufacturing paper pulp. U. S. patent 1,902,106 (March 21, 1933).

Sugarcane bagasse, corn stalks, or like material is digested with a solution containing a mixture of sodium carbonate, sodium sulfate, and sodium sulfide. The method of recovering the spent cooking liquor is described.

405. THOMSEN, ALFRED M. Process for the utilization of sugar cane bagasse. U. S. patent 2,031,239 (Feb. 19, 1936).—*T. S.* 103, 145; *C. A.* 30, 2384.

Sodium sulfide (free from sodium hydroxide) and sodium bisulfite are recommended as pulping agents for bagasse; digestion can be carried out at pressures as low as 30 pounds. For the best grades of pulp, it is essential to separate the pith from the woody fiber before cooking, but for inferior grades, both may be cooked together. The separation must be carried out before cooking; this may be accomplished in a pebble mill and by passage over a 20-mesh screen. Much of the patent relates to the recovery of the pulping liquor, which is claimed to represent a method of conversion of salt cake into higher priced chemicals.

406. To build paperboard mill in Puerto Rico. *Paper Trade J.* 118, no. 19, 16, 18 (1944); *Paper Mill News* 67, no. 19, 10 (1944).

A contract has been awarded to construct a paperboard mill for the Puerto Rico Development Company of San Juan, with an initial capacity of about 40 tons of paperboard per day for the manufacture of boxes and containers. The chief raw material will be waste paper collected locally and pulp from bagasse.

407. TRAQUAIR, JOHN. Fibrous Raw Materials Committee report—1946. *Tech. Assoc. Papers* 30, 148–51 (June, 1947); *Paper Trade J.* 127, no. 16, 55–8 (1947); *Tappi Bull.* 77 (March 28, 1947).—*B. I. P. C.* 17, 516.

The following comments are made on sugar cane bagasse: "The canes are all somewhat similar in general characteristics, sugar cane being the only one that has a solid core; the other canes are hollow. It is the only one which is presently collected and is available as bagasse at sugar mills. Sugar cane bagasse has found a large outlet in the manufacture of insulating and other boards, such as Celotex. Although numerous investigations have been made and plans projected for further use of bagasse, no other large scale use in the paper and paperboard industry has been developed. The reason for this is that bagasse yields a pulp consisting roughly of half fibers and half pith cells. The pulp dries to a resistant sheet which does not make down easily in water. Owing to the fact that the fibers and the pith differ tremendously in physical characteristics, it is very easy to fractionate the bagasse into two fractions, one consisting of a fibrous pulp about equal in quality to hardwood soda. The pith fraction, however, which can be collected on a vacuum filter, dries to a hard horny mass and can only be used in admixture with other pulps to impart to them stiffness and rattle. The problem is that two mills would have to be built to utilize bagasse and canes to best advantage; one mill to produce the cane pulp, and another to make a fibrous pulp, such as pine kraft, with which 25 to 50% of the bagasse pith could be mixed to impart certain desired characteristics."

408. TRAQUAIR, JOHN. Fibrous raw materials developments. *Paper Trade J.* 94, no. 26, 34–7 (1932); *Tech. Assoc. Papers* 15, 308–11 (1932).—*T. S.* 95, 172; *C. A.* 26, 5203.

Mention is made of the use of bagasse for the manufacture of Celotex. The use of bagasse as a source of bleached pulp has been developed only on an experimental scale in the United States. In Cuba, a factory has been erected and operated for some time producing a fairly satisfactory bleached pulp, which was shipped wet-pressed and was comparable with bleached soda pulp.

409. TROMP, L. A. Bagasse. I–III. *Intern. Sugar J.* 42, 59–63, 90–3, 135–7 (1940).—*C. A.* 34, 7135.

In the last article, mention is made of uses of bagasse, which include the manufacture of cellulose for rayon manufacture and pulp for paperboard.

410. Unfavorable opinion on bagasse. *Paper Makers' Mo. J.* 47, 310 (1909); *Paper Trade J.* 49, no. 7, 48 (1909).

411. Utilization of bagasse and molasses. *Intern. Sugar J.* 16, 378–82 (1914).—*C. A.* 8, 3729.

The report covers the use of bagasse as a fuel and for the manufacture of paper.

412. Valenzuela, A., and West, A. P. Composition of Philippine bagasse. *Philippine J. Sci.* 40, 257–81 (1929).—*C. A.* 24, 522.

Experiments have shown that a good grade of wallboard can be made from bagasse and that it is also adapted to the manufacture of paper. Possibilities for the production of artificial silk and pointed out, and analyses with that purpose in view were carried out. The material was ground and the portions passing through a 20-mesh and a 35-mesh sieve were analyzed. The alpha-cellulose content was 45%, lignin 15%, and pentosans 20%. The composition of Philippine bagasse does not meet the specifications of Avram, alpha-cellulose being too low and ash and copper number too high. The alpha-cellulose may possibly be used for the manufacture of commercial products. Bagasse, and the alpha-cellulose prepared from it, are not readily nitrated.

413. Valet, Earnest C. H. Process for extracting pure cellulose from sugar-cane bagasse. U. S. patent 1,630,147 (May 24, 1927); Reissue 17,422 (Sept. 3, 1929); British patent 277,163 (Aug. 25, 1926); French patent 620,897 (Aug. 31, 1926).—*T. S.* 86, 7, 255; 87, 228; 91, 184; *C. A.* 21, 2384, 2465.

The bagasse is cut into lengths of about one inch and treated in macerating tanks with a solution of 3–5% lime at a temperature below the boiling point; without washing, the material is transferred to a cooking tank and treated with a solution of about 6% sodium hydroxide and 2–3% of sodium sulfite, in the proportion of about 18 gallons of the former and 12 gallons of the latter for every 100 pounds of dry bagasse; 3% of lime may be added, depending upon the type of bagasse used. Steam is admitted to the tank and the bagasse is cooked at a pressure of 7–8 pounds for 4–6 hours. The tank is so arranged that the cover prevents motion of the bagasse in the tank by the action of the steam and the circulating steam. It is stated that this is important, for otherwise the yield would be greatly diminished. After washing, the pulp is bleached in any known manner.

414. Valet, Earnest C. H. Treating bagasse fiber for the production of paper pulp. U. S. patent 1,792,202 (Feb. 10, 1931); British patent 287,516 (March 23, 1927); French patent 650,194 (Feb. 29, 1928).—*T. S.* 90, 357; 91, 45; 93, 169; *C. A.* 23, 512, 3343; 25, 1996.

This patent claims an improvement over U. S. patent 1,630,147 (No. 413). The first step consists of reducing the moisture content of the bagasse as it comes from the mill and separating the longer fibers (suitable for cellulose manufacture) from the epidermis, parenchyma, and shorter fibers. About 300 kg. of the dry separated fibers are treated with 1,200–1,500 liters of a clear saturated solution of lime; the mixture is heated at about 90° C. for about 0.5 hour; to the fibers immersed in the lime solution (at 60–75° C.), are added 300–500 liters of sodium sulfite solution, the amount of sulfite being 0.5–2% of the weight of the fiber and the mixture is again heated at about 90° C. for 0.5–1 hour. The fibers are then separated and washed, after which they are treated with 1,000 liters of a solution containing 0.3–0.6% of potassium hydroxide, 3.5–5% of sodium hydroxide, and 0.5–1.5% of sodium sulfite, and heated at about 130° C. (1.5–2.5 atmospheres pressure) for 4–8 hours. The washed fibers are beaten with a solution of 1–3 kg. of Marseilles soap in 1,000 liters of water at about 50–70° C. The recovery of by-products from the various cooking solutions is discussed.

415. Vazquez, E. Antonio. Paper and board from bagasse. *Bol. ofic. asoc. técnicos azucar Cuba* 6, 79–87 (1947).—*C. A.* 41, 7746.

Alternate layers of bagasse and hydrated lime were packed into large tanks with sufficient water to cover and left until the lime had acted to free the fibers; 67.4% of fiber and pulp, calculated on the dry weight of the bagasse, were recovered. The pulp was suitable for making corrugated board for light packing cases. The amount of lime was 5 to 10% on the weight of the dry bagasse. The time required was from 10 to 30 days. Suggestions are offered for the practical application of the process.

416. Vazquez, Eugenio A. Apparatus for simultaneously making sugar and paper pulp from cane. U. S. patents 1,688,904 and 1,688,905 (Oct. 23, 1928). Cf. No. 87.

The apparatus consists of means for separating the cane by grinding or abrading it into individual fibers or aggregates of relatively few fibers and a solvent bath

for the extraction of the sugar from the comminuted cane. It is claimed that the fibers, since they have not been subjected to the crushing action of the usual sugar mill, are stronger and more suitable for the manufacture of paper or board.

417. Vazquez, Eugenio A. Cellulosic product. U. S. patent 1,782,751 (Nov. 25, 1930).—*T. S.* 92, 267.

The sugar cane is separated by grinding or abrading into individual fibers, which are dispersed in a solvent bath to remove the sugar, the operation being repeated until the sugar is completely extracted. It is stated that almost complete extraction can be obtained with only 30% dilution of the natural juice content of the cane. An apparatus is specified. When the cane is treated by this process, it is claimed that the pith need not be removed, and that a good grade of pulp is produced, utilizing all the cellulose contained in the cane. The fiberless cellulose in which the cells have been ruptured may even improve the quality of the paper, because it is readily hydrated to form a binder for the fibers. The pulp resembles in many respects mechanical wood pulp and may be similarly used alone or in admixture with chemical pulps for the production of newsprint, board, etc. Further, the fibers may be subjected to a chemical treatment to dissolve any remaining noncellulosic material for the production of pure cellulose or chemical pulp. Such chemical treatment is greatly facilitated by the comminuted condition of the pulp.

418. Vazquez, Eugenio A. Recovery of by-products of sugar extraction. U. S. patent 1,876,522 (Sept. 6, 1932).—*T. S.* 95, 307; *C. A.* 27, 204.

The bagasse is placed in large vats or tanks, where it is covered with a solution of lime (approximately 5–10% based on the dry weight of the fiber), and allowed to remain for a sufficient time for the lime to react with the constituents of the bagasse, which bind the individual fibers together, to loosen these fibers; this may require 3–4 months. The bagasse and lime solutions are fed to the crushing or dispersing and agitating equipment, depending upon which of the two processes is in use in the mill. After screening or straining, the fiber is suitable for further treatment, such as bleaching, etc. Suggestions are given for the recovery of products (lime, fertilizer, salts of organic acids) from the sludge which settles out from the liquor used for treating the bagasse.

419. Vincent, George P., and Dubeau, Archie L. Purification of cellulosic material. U. S. patent 2,407,909 (Sept. 17, 1946).—*C. A.* 41, 1104.

Crude pulp (e. g., that from bagasse) is impregnated with at least 4% sodium hydroxide, subjected to a steaming process at 100° C. for 30 minutes, washed with hot water, impregnated with a solution containing 1% available chlorine as sodium chlorite, 0.5% detergent, and 3% acetic acid, and again steamed for 0.5 hour. The treatment gives a relatively pure cellulose suitable for acetylation, nitration, paper manufacture, and the like. The viscosity characteristics can be controlled by an intermediate treatment with aqueous sodium hypochlorite.

420. Vivas, F. S. Fire-resisting wall board. U. S. patent 1,754,843 (April 15, 1930).—*T. S.* 92, 145.

A wallboard, made of pulp from bagasse, cornstalks, straw, or wood pulp, is impregnated with an insoluble calcium resinate soap binder.

421. Wallace, J. H. Possibilities of bagasse for paper making. *Paper* 24 451–2 (1919); *Sugar* 21, 233–4 (1919); *Paper Mill* 42, no. 24, 54, 56 (1919); *World's Paper Trade Rev.* 72, 412, 414, 416 (1919); *Paper-Maker* 59, 487–8 (1920); *Paper Making* 38, 222–4 (1919); *Papeterie* 41, 407–11 (1919).—*C. A.* 13, 1545, 1763.

This is largely a historical account of the attempts to manufacture paper from bagasse. It is stated that Routledge made high-grade paper from bagasse as early as 1856; for economic reasons, esparto was chosen.

422. Wealth from waste. *Indian Pulp and Paper* 4, 226 (1949).—*B. I. P. C.* 20, 504.

A fine paper mill is being constructed at Dalmianagar in Bihar, India, which will utilize bagasse as a raw material. The Celdecor-Pomilio process will be used; the machinery will come from Great Britain.

423. Wells, Sidney D. Paper pulpmaking process. U. S. patent 2,029,973 (Feb. 4, 1936).—*C. A.* 30, 2000.

This process involves the use of the rod mill. It can be applied to bagasse, cornstalks, straws, etc. The outline of the process is as follows: The raw ma-

terial is subjected to a preliminary washing to remove soil, vegetable dust, and other foreign matter; it is then pressed or crushed between press rolls and fed into a rod mill, wherein it is subjected to the pounding, beating, and rubbing action of rods and the action of semispent liquors obtained from the subsequent more complete digestion of the material. It is then freed from the waste liquor in a screw press (the liquor goes to chemical recovery) and separated from pith. The fibrous portion is digested with fresh cooking liquor (about 20 minutes are required because of the rod-mill treatment). From the digester it passes through a cyclone separator and a counter-current washer, after which the product is bleached.

424. Wells, Sidney D., and Atchison, Joseph E. Production of pulp from the fibrous elements of sugar-cane bagasse. *Paper Trade J.* 112, no. 13, 34–8 (1941); *Tech. Assoc. Papers* 24, 114–8 (1941); *Paper Ind.* 22, 1306, 1308 (1941).—*B. I. P. C.* 11, 260; *B. C. P. A.* 1941B, II, 219; *C. A.* 35, 4198.

It is possible to separate the pith cells from the fibrous elements of raw sugar cane bagasse by means of a preliminary rod-mill treatment with hot caustic followed by a screening operation on a gyratory screen. The optimum conditions for the rod-mill treatment are as follows: 15% consistency, 9% caustic on the basis of the moisture-free bagasse, and a duration of 20 minutes at 95 to 97° C. The pith fraction consumes chemical more rapidly than the fibrous fraction; therefore, for economy of chemical consumption, it is desirable to remove the pith as early in the process as possible and with just sufficient chemical to effect a separation of the pith cells and fines, which can be screened out. The presence of a large proportion of pith in the pulp renders it more difficult to bleach, tends to slow up excessively the beaten stock, and greatly decreases the strength properties. A high quality, easily bleachable pulp can be produced from the fibrous fraction by either a mild soda or sulfate cook with a straight-line temperature rise to 160° C. over a period of from 120–130 minutes. The sulfate process gives a slightly higher yield of pulp that is more easily bleached than the soda cook with the same concentration of active alkali. The pith may be mixed with kraft pulp to produce a paperboard with all the strength properties (except tearing resistance) showing an improvement over those of a kraft paperboard. As much as 70% pith may be used. The presence of pith actually increases the stiffness of the paperboard and improves its appearance and formation. On the basis of a delivered price of $5 per ton for bagasse and a value of $10 per ton for the pith fraction in paperboard manufacture, the cost of the bleached fiber is not over $36 per ton under conditions that prevailed in 1940.

425. Wells, Sidney D., and Muggleton, Gerald D. Paper pulp and method of making the same. U. S. patent 2,018,937 (Oct. 29, 1935).

The basis of this invention is the use of the rod mill. The process may be applied to bagasse, cornstalks, straw, and the like. After a preliminary washing to remove soil and other foreign matter, the material is passed through a roll press where it is crushed, and then to a rod mill, wherein it is subjected to the pounding, beating, and rubbing action of rods, to the action of caustic soda or other cooking liquor, and to the action of the heat resulting from the condensation of the steam which is blown into the rod mill. The product then passes through a screw press, after which it may be bleached in a conventional manner. The paper prepared from the pulp is suitable for newsprint, catalog paper, and the like.

426. West, Clarence J. Bagasse for papermaking. *Paper Mill* 44, no. 12, 54, 56 (1921).

427. West, Clarence J. History of bagasse for papermaking. *Paper Trade J.* 70, no. 21, 52, 54 (1920); *Paper Makers' Mo. J.* 58, 212–4 (1920).

The use of bagasse for paper and board is traced from the early experiments of Routledge (1856).

428. West, Clarence J. Paper from bagasse. *Paper* 26, no. 2, 26, 28 (1920); *Sci. Am. Monthly* 1,283 (1920).

A brief discussion of the pulping of bagasse, with special reference to the Eckart process, which uses bagasse paper as a mulch.

429. WHITTEMORE, E. R., REID, J. DAVID, and LYNCH, D. F. J. Nitric acid pulping. Analysis of the used-acid pulping liquors. *Ind. Eng. Chem.* 30, 1192–8 (1938).—*C. A.* 32, 9489.

A method of conductometric analysis is described for the rapid determination of the principal acidic and salt constituents of nitric acid pulping liquor for bagasse. Two methods of digestion were studied. In the first, drain and wash pulping liquors were mixed and concentrated to about the optimum concentration required for digestion. The nitric acid consumption was about 15 grams per 100 grams of bagasse. During the evaporation, the nitric acid apparently acts on the organic material present in solution to produce organic acids. The volatile acids that distill duringthis time are equivalent to about 7.5% of the total acid originally present. There was a saving of about 3 grams of nitric acid per 100 grams of bagasse by recovery of the wash liquors and a loss of about 4 grams during the concentration, a net loss of one gram. In the second method, only the drain liquor was recovered. The nitric acid consumption was 20 grams per 100 grams of bagasse. However, nearly 20% of this is due to washing losses, the consumption resulting from the reaction being about 15.5 grams per 100 grams of bagasse. The organic material present is probably oxidized during the succeeding cook. The consumption of nitric acid in a series of runs, therefore, is approximately the same. Formic and oxalic acids are produced in the pulping operation and their concentration reaches a practical equilibrium of about 0.2% after a few runs. Acetic acid is formed and has a tendency to increase slightly with each run, unless the used liquor and wash are concentrated, in which case the acetic acid approaches an equilibrium similar to that reached by formic acid. Ammonia is formed and fixed as the nitrate. Reducing materials, mainly sugars, increase tremendously, rising to 2.6% after the first three cooks and to nearly 4% in the twelfth cook.

430. WIKOFF, A. G. Insulating lumber from sugar mill bagasse. *Chem. Met. Eng.* 29, 360–2 (1923).—*C. A.* 17, 3593.

A general account is given of the development of Celotex. Properties of the various materials are given. A more complete account is given by Lathrop.

431. WILLIAMS, WM. L. S. Use of bagasse in wall board manufacture. U. S. patent 1,782,755 (Nov. 25, 1931).—*C. A.* 25, 416.

Bagasse as it comes from the sugar mill is separated into fiber and pith as far as is mechanically possible by screening, blowing, or other mechanical means; in general, the pith cells form about 15% of the total weight of the bagasse. The fibrous portion is digested with 2–10% of hydrated lime for from 30 minutes to 10 hours under a steam pressure of from 50 to 125 pounds per square inch. Other chemicals (sodium hydroxide, soda ash, or the like) may be used. The pith portion of the bagasse is cooked with water at 212° F. for about 4 hours or until it has the same state of hydration as the fibrous portion. The two stocks are then mixed and formed into insulating board; the yield of board is 90% of the original raw material.

432. WILLIAMS, WM. L. S. Method of treating bagasse. U. S. patent 1,847,050 (Feb. 23, 1932).—*T. S.* 95, 174; *C. A.* 26, 2595.

The shredded bagasse fibers are first passed over one or more vibratory screens to remove the major portion of the pith. The separated fibers are then cooked in a rotating digester with 4–6% of lime at a pressure of 60–80 pounds and a temperature of 300–320° F. for about 4 hours; the pith is stripped from the fibers during cooking by mechanical abrasion. The dissolved pith and extracted matter are removed by washing, after which the fibers are pulped. It is claimed that a wallboard made from this material is stronger and lighter in weight than that heretofore manufactured.

433. WILSON, EDWARD. Megasse compared with esparto. *Paper-Maker* 45 no. 2, 233 (1913); *World's Paper Trade Rev.* 59, no. 5, 238 (1913).

One paper mill made the following report on the use of bagasse: The fiber is very cellular and would be a good carrier for china clay. It pulps easily with 10 pounds of 60% caustic soda per hundredweight, which is 6 pounds less than for esparto; there is a loss of 50% on pulping, because of the pith. Bagasse requires 4 hours for pulping, as compared with 6 hours for esparto. The pulp is not bleached as easily as that from esparto. The loss in bleaching was 10% and the total loss in manufacture was 60%, as compared with 55% for the total loss for esparto. If treated under ordinary papermaking conditions, it would produce a serviceable paper.

434. WITHAM, G. S., SR. Modern pulp and paper making. 2nd ed. New York, Reinhold, 1942.

Bagasse is discussed on page 50. "Of all the different materials investigated during the last few years, during which period millions of dollars have been spent to advance the art of cellulose utilization, few materials have received more attention than bagasse, the residue of sugar cane after the juice has been pressed from it. . . . It has been found that bagasse contains fibers of high quality suitable for many grades of paper. The sugar-cane stalk is largely composed of two constituents, fibrous cellulose, and non-fibrous cellulose in about equal parts. A process is now being investigated whereby these two constituent parts can be separated mechanically and the fiber treated chemically either by the soda or the sulphite process. Bagasse boards are manufactured in Louisiana by the Lee process, in which the bagasse is digested with a liquor prepared by treating low-grade molasses from the sugar mills with lime, its principal constituent being saccharate of lime. The boiling causes a hydration of the non-fibrous cellulose which toughens it and thus makes it possible to make pulp out of material that really hardly contains any fibers at all, the cells of the non-fibrous cellulose being too short to be correctly called fibers. Interesting experiments have also been carried out on making semitransparent, glassine, and parchment paper from bagasse by utilization of this hydration effect."

435. WREDE, HANS. Bagasse in Cuba. *Papier-Fabr.* 9, 1029–34 (1911); *Paper-Maker, Annual No.* 1911–1912, 210; *World's Paper Trade Rev.* 56, 112, 484 (1911); *Paper* 4, no. 3, 9–11 (1911); *Paper Making* 30, 374, 376 (1911); *Paper-Maker* 42, 212–3 (1911); *Chem. Ztg.* 36, 205–6 (1912).—*C. A.* 6, 422.

Reference is made to the McMillen process of drying sugar cane, which is being used at Preston, Cuba; the process also separates the cane into various fibers; the cane is shredded by rotary knives and the fibers are separated by rotary sieves. The following analysis of the fiber and pith is given:

	Fiber	Pith
Moisture	8.2	6.1
Sucrose	33.1	50.4
Glucose	2.1	3.4
Nonsugars	9.9	5.1
Fibers	46.7	35.0

The dry sugar-cane products are pressed and exported in bales. Mention is made of the possible recovery of a wax. In some beet sugar mills, the sugar is abstracted by diffusion and the fiber is used for pulp, the quality of which is superior to white straw but inferior to esparto. The process proposed by the author is not indicated but is said to be characterized by the fact that a white pulp may be obtained without the use of considerable quantities of chloride of lime. The product resembles an absorbent powder and is said to be useful for the manufacture of cellulose nitrate.

436. WREDE, HANS. Utilization for papermaking of bagasse and other West Indian fibers. *Wochbl. Papierfabr.* 42, 582–4 (1911).—*J. Soc. Chem. Ind.* 30, 278; *C. A.* 5, 3154.

The West Indies and Central and South America are extraordinarily rich in vegetable materials which, under proper development, are capable of supplementing the supply of paper-making fibers, particularly in the United States. The sugar factories of Jamaica treat 65,000 tons of sugar cane annually but, on account of the absence of local supplies of coal, the bagasse and all other available wastes possessing a fuel value are utilized for steam raising. This is one of the main obstacles to the establishment of a pulp industry. The negative results which have hitherto attended attempts for the utilization of bagasse, without experienced direction, must not be taken too seriously, because it has been proven that, with proper organization, good results are to be expected. The soda process is evidently unsuitable, and the sulfate process shows a much better prospect. Possibly a combination of the sulfate process with a special modification of the sulfite process will provide an ultimate solution of the problem. Other raw materials are discussed.

437. Yatsuhama, Yoshikazu. Bagasse pulp for paper manufacture. *Kagaku Kogyo Jiho; Intern. Sugar J.* 40, 39 (1938).—*C. A.* 32, 8138.

Bagasse does not differ much from coniferous wood fiber as raw material for the manufacture of paper pulp, but it contains less lignin. The sulfite process is not applicable to it, but the nitrate method can be employed to advantage, giving a pulp containing not more than 7% of pentosan and 88–90% of alpha-cellulose. For rayon manufacture, the pulp is unsuitable, its fibers being too short and its impurities too high.

PLASTICS

438. Aries, Robert S. Chemurgy and the war. *Chem. Industries* 52, 188–92, 259 (1943).—*B. I. P. C.* 13, 325.

A brief review is given of the work of Sweeney and Arnold on corncob plastics and of the work of Aronovsky and Clark and of McElhinney on bagasse plastics. Tables are reproduced giving the cost of the raw materials and the physical properties of the bagasse plastics.

439. Aronovsky, S. I., and Clark, T. F. Plastics from bagasse and other agricultural residues. *Mfgrs.' Record* 110, no. 3, 22–5, 59 (1941); *Intern. Sugar J.* 43, 371–3 (1941).—*B. C. P. A.* 1942B, II, 76; *C. A.* 35, 3357; 36, 1694.

Bagasse was digested at 135 pounds pressure with 1% sulfuric acid for 30 minutes. The resulting material was dried, ground, and molded at 3,500 p. s. i. and 163° C. with 8% each of furfural and aniline. The specimens had a flexural strength of approximately 7,000 p. s. i. and only 2.7% water absorption. Aniline and alkali-furfural digestions also gave good plastics. Cost figures show these to be very inexpensive molding compounds.

440. Chen, C. C. Lignin plastics from bagasse. *Taiwan Sugar J. Quart.* 1, 89–101 (1948).—*C. A.* 44, 4713.

Conditions for the preparation of lignin plastics from bagasse by the acid hydrolysis method and the phenol-acid digestion method are reported. The best results with acid hydrolysis are achieved by heating the bagasse with 3% of its weight of sulfuric acid at 175° for two hours. The yield of hydrolysis products is 64.4% by weight, containing 42.2% by weight of lignin. In the phenol-acid digestion, heating with 19 to 22% phenol and 4% by weight of sulfuric acid at 160° for two hours is most satisfactory. Molding of test samples is carried out at 160° under a pressure of 50 kg./sq. cm. for five minutes and at 200 kg./sq. cm. for another five minutes. Addition of 15% of formaldehyde (37% by weight) as a plasticizer improved the strength of the products better than using other simple or combined plasticizers. Addition of metal oxides or salts improves the luster of the products but decreases the strength. With formaldehyde as the plasticizer, the products from the acid hydrolysis have the following properties: moisture absorption 1.10%, specific gravity 1.334 g./cc., hardness (Shore) 57, tensile strength 154 kg./sq. cm. The corresponding products from the phenol-acid hydrolysis have the following properties: moisture absorption 1.82%, specific gravity 1.385 g./cc., hardness (Shore) 69, and tensile strength 228 kg./sq. cm. All the products are highly resistant to acid and are only slightly soluble in ethyl alcohol. The alkali resistance, however, is very poor.

441. Clark, T. F., and Aronovsky, S. I. Agricultural residues, a comparative study. *Modern Plastics* 22, no. 4, 162–4, 198, and 1 folded table (1944).—*B. I. P. C.* 15, 174.

This study included corn stover, cornstalks, corncobs, wheat, oat, and rye straws, flax shives, bagasse, tobacco stalks, and oat hull residues. Four methods of hydrolysis were investigated: 1% sulfuric acid for 30 minutes at 385° F. (135 pounds/square inch steam pressure); 21% aniline for 180 minutes at 384° F. (190 pounds/square inch steam pressure); 30% caustic soda and 12% furfural for 8 hours under reflux conditions, followed by acidification and boiling with sulfuric acid at pH 4, filtration, and washing of the pulp and coagulated lignin; water for 60 minutes at 366° F. (150 pounds/square inch steam pressure). The following table gives the analysis of the resulting products (data for bagasse only):

	Yield %	Ash %	Lignin %	Pentosans %	Extractives %
Raw material		3.00	20.5	30.0	0.37
Water cook	68.9	3.23	32.6	5.0	16.46
Acid cook	62.0	5.07	33.3	2.5	10.00
Aniline cook	85.3	1.04	55.2	2.8	19.2
Alkali-furfural cook	70.7	1.92	32.5	21.5	3.9

The products were molded as such and after the addition of 8% each of aniline and furfural, 8% each of phenol and furfural, and 8% of furfural. The molding was carried out at a pressure of 4500 pounds/square inch and a temperature of 160° to 165° C. during the curing period. The compositions were placed in the molds at 120° to 125° C. and maintained under pressure throughout the heating, curing, and subsequent cooling periods. Complete data are given for the physical properties of the molded products. The data do not permit a critical evaluation of the various plant residues for plastic molding compositions. However, they indicate the possibility of the use of these materials for the production of molding compositions. The types of treatment given the raw materials and the types of plasticizers employed apparently have much greater effect upon the characteristics of the compositions than do the raw materials themselves.

442. Dusenbury, Millard R. Ligneous resinous compositions. U. S. patent 2,410,205 (Oct. 29, 1946).—*C. A.* 41, 4002.

Bagasse, peat moss, or a wood is heated with water and a higher fatty acid or its ester containing a conjugated system of double bonds at 240–330° C. until the cellular structure of the material has disappeared and the water is removed to give the resin. Thus, 66 parts of tung oil fatty acids were dissolved in sufficient acetone to cover 154 parts of spent pinewood chips from which the turpentine, rosin, and oils had been extracted. The acetone was distilled off, the impregnated chips were placed in an autoclave, covered with 550 parts of distilled water, and heated at 260–270° C. for one hour. Removal of the water gave 143 parts of resin. Oiticica oil can be used in place of the tung oil. The resins are characterized by freedom from cellular material and by a relatively dark color; they are soluble in acetone, Cellosolve, and carbitol; partly soluble in benzene or toluene; and insoluble in gasoline hydrocarbons. When dry, the melting point may vary from 50 to 200° C. They can be used in molding compositions and plastics, as a dry core binder, in core oils and their emulsions, in asphalt emulsions, as a binding material for fibrous building boards, in dense pressed boards, and in bonding insulation boards.

443. Hu, Y., and Wen, Y. L. Lignin plastics made from bagasse. *Taiwan Sugar J. Quart.* 1, 102–7 (1948).—*C. A.* 44, 4713.

Bagasse is heated at 150° with 0.2% sulfuric acid, 10 to 16% furfural, or 20% aniline for two or three hours. The products of hydrolysis, mixed with various quantities of phenol-formaldehyde or furfural-aniline resin and 1% zinc stearate, are molded at 160° under a pressure of 200 kg./sq. cm. for 20 minutes. The luster, hardness, tensile strength, and absorption of moisture of the different products are compared. Addition of phenol-formaldehyde resin yields products of higher tensile strength and hardness, but the luster is not as good as that of the products made with the furfural-aniline resin. The optimum quantity of the phenol-formaldehyde resin is 25% of the weight of the hydrolysis product used. The moisture absorption of both kinds of products is low. Aniline or furfural hydrolysis yields products of higher tensile strength than sulfuric acid hydrolysis. The skin part and the powder part of bagasse, as well as the unseparated bagasse, have been tested with the result that the latter yields the best product.

444. Irvine, Fergus A. Process of manufacturing hard board. U. S. patent 2,044,213 (June 16, 1936).—*T. S.* 103, 396; *C. A.* 30, 5335.

Bagasse is digested with water for 2–3 hours at 45–50 pounds pressure or with 8% lime for 2 hours at 40 pounds pressure. After refining in a beater, Jordan, or other refiner, the pulp is mixed with 1–5% of tung oil (other drying oils, linseed oil, or synthetic resins in an intermediate stage of polymerization may be used), and pressed at about 325° F. and 200–225 p. s. i. for about 15 minutes. To complete the polymerization of the oil, the boards are held in a heated condition for

6–24 hours. A product made with 2% tung oil shows an increased tensile strength (from 4,000 to 6,000 p. s. i.) and a decreased water absorption (from 100% in 2 hours to about 15% in 24 hours).

445. Irvine, Fergus A., and Frederick, Emile, Jr. Molded product. U. S. patent 2,402,554 (June 25, 1946).—*C. A.* 40, 5600.

A cellulose-filled synthetic-resin molded article is prepared in one step. A cellulosic fiber, such as bagasse, containing 7 to 11% moisture is heated under pressure at 500–1,500 p. s. i. to 345–395° F. for 10–12 minutes in a gastight mold. The gas pressure is reduced to that of the atmosphere through an attached valve and the external pressure is then built up to the original full pressure for 2–4 minutes. In this process the lignins are converted to a synthetic resin which is firmly adhered to the cellulosic filler. The product has a density of 0.8 to 1.2 and a tensile strength of 1,600 to 4,000 p. s. i. Evidence for the formation of a resin are the decrease from 3.3% benzene-soluble material in the original material to 1.9% in the finished product and the impossibility of pulping the product. The gases formed in the heating must be retained in the compressed mass and are said to act as catalysts.

446. Irwin, Jesse M. Process of producing a molding powder. U. S. patent 2,486,601 (Nov. 1, 1941).—*B. I. P. C.* 20, 608.

A process is described for the production of a molding powder from a lignocellulosic material such as wood, bagasse, straw, and the like. The example given deals with hardwood. The wood (40 pounds), one pound of sulfur, and 80 pounds of water in a digester are heated to a steam pressure of 150 to 200 pounds per square inch and a temperature of 388° F., held under those conditions for five minutes, the digester is relieved, and then heated at 200 pounds per square inch for 20 minutes. The dried material is ground to pass a 40-mesh screen. The ground material is molded at a pressure of 4,000 pounds per square inch and a temperature of 300° F. for five minutes; the molded product is dark brown to black, has high strength, and a density of 1.44.

447. Kline, Gordon M. Advances in plastics during 1941. General review. *Modern Plastics* 19, no. 5, 57–9 (1942).

Toward the end of the year considerable attention was devoted to the possibilities of certain natural products in extending the available supplies of molding powders. Of primary interest in this connection were furfural, lignin, soybean meal, and bagasse. Producers and molders alike are accumulating a background of experience in processing these materials and a stage has been reached at which selection of particular formulations for concentrated commercial use is feasible.

448. Kruse, W. T. Use of bagasse for manufacturing plastics. *Mem. 14th conf. anual, Asoc. tec. azucar. Cuba* 1940, 327–9.—*C. A.* 35, 5209.

A review.

449. Lignocellulosic products. *Modern Plastics Encyclopedia* 1948, 207–8; 1949, 298; *Modern Plastics Encyclopedia and Engineer's Handbook* 1950, 658.

Bagasse, the lignocellulosic residue of cane sugar manufacture, is among the agricultural residues which have achieved commercial success. General purpose and semi-impact molding compounds are available which mold well, and have excellent preforming characteristics and rapid curing cycles. Thermosetting bonding resins have also been developed which are suitable for use with paper, cloth, veneers, and other materials. Characteristics of these are their solubility and rapid cure properties at relatively low temperatures and pressures. After cure they are flexible and water resistant. Resins of the thermoplastics type have likewise been developed. Dark brown in color, they can be used with or without shellac in the manufacture of phonographic records. For earlier review see Nos. 450 and 453.

450. McElhinney, T. R. Bagasse molding compound. *Plastics Catalog* 1943, 214, 216; 1944, 274; 1945, 214.

A brief review is given of the bagasse molding compound, sold under the trade name Valite. It is similar to other articles by the same author.

451. McElhinney, T. R. Bagasse molding compounds. *Modern Plastics* 20, no. 3, 64–5, 136 (1942).—*B. I. P. C.* 13, 155.

The initial product developed under the Forest Products Laboratory patents showed certain shortcomings, chief among which were the excessively long curing time required, poor flow qualities, and excessive gassing during molding. The

process was originally based on the production of a resin in situ in the bagasse and the treatment necessary to give the resin the desired characteristics almost entirely destroyed the strength of the fiber filler remaining. At the same time, so much of the degraded fiber was still present admixed with the resin, that the compound would not tolerate the addition of more filler to strengthen it without too much loss in flow. Therefore, the process was divided into two parts: the development of a resin from bagasse without destruction of the fibrous and nonreactive portions, and a parallel development of a satisfactory filler from bagasse. A filler was developed, some inherent property of which allows it to combine with the bagasse resin in such a way that flow and strength qualities are much better than when woodflour is used. Substitution of phenolic resins for the bagasse resin with this filler gives opposite results, although the reason for this has not been determined. Data are given on the physical properties of four typical bagasse plastic compounds; all of these mold readily at temperatures of 300–350° F. at pressures of 2000 pounds per square inch and up. Curing time is about 1 minute in a ⅛-inch wall thickness. An unusual property of these compounds is the exceptional softness and flexibility of the material when first ejected from the mold, even after protracted curing periods. This softness does not occur again on reheating, even to temperatures as high as 400° F. Laminating resin is available in the form of a 40% alcoholic solution. Boards can be molded in a 1/16-inch thickness in 2–3 minutes at 280–300° F. and pressures of 1500 p. s. i.

452. McElhinney, T. R. Bagasse resin laminates. *Modern Plastics* 23, no. 3, 121–3 (1945).

The basic resin used for the manufacture of the Valite resins is produced by a high-pressure digestion of bagasse. This resin is a semi-solid material almost completely soluble in alcohol and acetone. In this state it is used as a binder for thermosetting molding compounds, requiring only the addition of hexa or other hardening agent. For laminates, it is subjected to further processing to render it more soluble and to increase its penetrating power. The finished resin comes from the autoclave as an alkaline alcoholic solution of pH 8.5 with a solids content of between 55 and 60%. Two types of Valite have been developed in the laboratory: No. 8123 is a quick-curing resin, with a viscosity of 350 to 500 centipoises in 55% alcoholic solution; No. 8142 is somewhat slower curing and has a viscosity of 3000 centipoises at the same concentration. The latter is somewhat more difficult to use because of its low penetrating power, but has the advantage of producing a very flexible bond and appears to be well adapted to post-forming operations. With the use of a home-made impregnating apparatus, laminates were prepared from Valite No. 8123 and high-strength sulfite paper, absorbent kraft paper, southern kraft paper, 8-ounce cotton duck, and heat-treated glass fabrics. A table gives the physical properties of these products. The properties, with the exception of moisture absorption, in most cases exceeded the minimum A. S. T. M. specifications for similar grades of laminates by a considerable margin. Aging tests showed that the treated material can be stored for at least two months at normal room temperatures without loss in physical properties. Laminates were also made from Valite Nos. 8123 and 8142 and absorbent kraft paper; the average strengths of the two laminates were approximately equal.

453. McElhinney, T. R. Plastics from agricultural products. *Modern Plastics Encyclopedia* 1946, 234–6; 1947, 182–3.

One section discusses briefly bagasse plastics. For other reviews, see Nos. 449 and 450.

454. McElhinney, Thomas R. Synthetic resin and process of making same. U. S. patent 2,394,000 (Feb. 5, 1946).

A Novolac resin is prepared as follows: Dry bagasse (1000 parts) and 1000 parts phenol containing 50 parts concentrated sulfuric acid are heated in a rotary digester for 30 minutes with live steam at 225 pounds per square inch. The product is washed with water and dried at 300 to 400° F. The final product is a lustrous black resin, hard at room temperature and incapable of being permanently hardened even with prolonged heating. The yield is about 120% of the phenol. The resin is suitable as a varnish ingredient or as a binder for molding compounds. This resin may be compounded with bagasse (after digestion with 10% calcium hydroxide for one hour at 100 pounds steam pressure) to form a hot molding composition. If the resin is heated with sodium hydroxide in the

presence of a phenol and formaldehyde (solvents for the resin) there results a black or dark brown semisolid material which is capable of being hardened to an infusible insoluble material by further heating.

455. McElhinney, Thomas R. Synthetic resin. U. S. patent 2,560,299 (July 10, 1951).—*C. A.* 45, 9304.

A heat-hardening synthetic resin, which is soluble in water, can be made by the acid hydrolysis of phenol and a lignocellulosic material with live steam under pressure. The substance is then heated with agitation in a sodium hydroxide solution until melted and formaldehyde is added. The mixture is boiled and an aqueous diluent is added to stop the reaction.

456. McElhinney, Thomas R. Synthetic resins from phenols and lignocellulosic materials. Canadian patent 470,237 (Dec. 19, 1950).—*B. I. P. C.* 21, 443.

A phenol is reacted with a lignocellulosic material (e. g., bagasse, straw, corn stalks, and the like) in the presence of 5% of concentrated sulfuric acid (based on the weight of the cellulosic material) and live steam at 225 pounds per square inch for about 30 minutes. The resulting product is a Novolac-type resin.

457. McElhinney, T. R., and Aronovsky, S. I. Aniline-bagasse plastics. *Modern Plastics* 17, no. 10, 59–61, 88, 90, 92, 94 (1940).—*B. I. P. C.* 10, 430; *C. A.* 34, 5564.

Details are given of some 25 runs to determine the best conditions for the preparation of bagasse plastics using aniline, furfural, or phenol, and various combinations of these. The following conclusions are drawn from this work. Properties of molding compounds prepared from bagasse by the aniline digestion method can be varied through a wide range. The water-to-bagasse ratio in digestions should be high for maximum strength and low for maximum flow and water resistance. The aniline used should be from 20–25% of the weight of the original dry bagasse. Digestion pressures should be low for maximum strength and should be high for maximum flow and water resistance. Digestion time should be approximately 3 hours in order to hydrolize completely the plant constituents which cause sticking in the mold. Shorter times of digestion will increase strength but it is preferable to digest for longer periods at lower pressures. Ball milling, in the manner used, is not the best method of mixing with plasticizers and seems to destroy fiber strength by grinding. Mixing time is relatively unimportant, but should be long enough for thorough reaction and incorporation of the plasticizing chemicals. Plastic molding compounds can be prepared by the aniline-digestion method with sufficient strength and flow to be used for many articles where low cost of molding powder is of prime importance. The relatively long molding cycle (22–35 minutes) used in this experimental work could be cut down to a very considerable extent in large-scale commercial practice, using cored multiple molds. More details of the work are not given because of the more recent work of McElhinney (No. 451).

458. McElhinney, T. R., Clark, T. F., and Lynch, D. F. J. Low-cost molding material from agricultural wastes. *Modern Plastics* 16, no. 7, 42–4, 70, 72, 74 (1939).—*B. I. P. C.* 9, 361; *T. S.* 110, 131; *C. A.* 33, 5939.

Sufficient study has been made of plastics prepared from agricultural wastes (such as bagasse) to show that these materials offer a good potential source of inexpensive molding powders suitable for the manufacture of large, flat, or nearly flat articles. Three methods of treating the lignocellulose material to produce molding compositions are proposed, none of which has been carried to a stage where the plastic exhibits an entirely satisfactory performance, although each product has properties to recommend its use. Plastics produced by hydrolysis with acid offer the greatest degree of moisture resistance but are somewhat deficient in strength. These powders in their present stage of development would probably be suitable for molding such articles as bathroom tile, where strength is not as important as water resistance. Pieces made by hydrolysis in the presence of aniline were only slightly less water resistant than the best made from the acid hydrolyzed powder and were much stronger. One specimen had a breaking test of 9,000 p. s. i. The flow was not as good as in the case of the acid-hydrolyzed powders. Warping after molding seemed entirely absent. This powder would appear to have a much greater value in preparing materials for structural units. It may be sawn, drilled, and tapped and, if care is taken, nailed. The sodium hydroxide-furfural method gives products which have characteristics midway between the other two. Flow is very much improved and strength is excellent,

with an individual specimen having a breaking strength of almost 7,000 p. s. i. Moisture absorption was very high in the piece tested and a waterproofing agent will be necessary for special uses. Articles prepared by either the aniline or the sodium hydroxide-furfural method are very resistant to shattering when struck by a hammer or dropped and, even when struck with sufficient force to show surface checking, they are still very resistant to final breaking. Materials from the acid-hydrolyzed powders can be dropped from considerable heights without breaking but have a tendency to shatter when struck. A table gives the conditions of preparation and the properties of 10 plastics from bagasse and 2 from corncobs.

459. Masonite Corporation. Molding material. British patent 497,477 (Dec. 16, 1938).—*C. A.* 33, 3921.

A material for manufacture by hot pressure molding of dense, water-resistant, amorphous products is obtained by subjecting lignocellulose, e. g., wood chips, sawdust, cornstalks, cane bagasse, and straw, to the action of heat and moisture for a longer period of time and (or) at a higher temperature and pressure than employed in known methods of reducing lignocellulose to a coarse fibrous state [as described, e. g., in U. S. patents 1,578,609 (C. A. 20, 1905) and 1,824,221] until it is converted into a predominantly plastic state, i. e., has useful flow properties when molded in the manner usual for synthetic resins. In a modification, molding material is obtained by separating from the products of the above-mentioned known methods the predominantly plastic by-products that are produced, e. g., by screening. In another modification, the molding material may be obtained by subjecting the lignocellulose to the action of heat and moisture for a considerably longer period of time and at a lower temperature than is employed in the above-mentioned known methods until it is converted to a predominantly plastic state and reducing the material to the fineness necessary for molding. Molded products made from material made according to this modification are not so water resistant as the others. Incompletely converted material in the mass acts as filler. Resins, fillers, lubricants, or pigments may be added to the material.

460. Molitor, J. B. Bagasse base resins for the plastics industry. *Ind. Plastics* 2, no. 1, 30–1 (1946).—*C. A.* 40, 4909.

A brief discussion is given of two thermosetting resin varnishes prepared from bagasse: Valite 8123 and Valite 8142. Tables give the physical properties of laminates made with Resin 8123, the effect of age on paper treated with Resin 8142, and a comparison of laminates made from kraft papers impregnated with each of the resins.

461. Molitor, John B. Industrial by-products from sugar cane. *Sugar J.* 11, no. 10, 3–5, 24 (1949).—*C. A.* 43, 9501.

Progress in producing plastics (Valite) and other chemicals from bagasse is reviewed.

462. N. V. de Bataafsche Petroleum Maatschappij. Carbon-containing ion-exchange material. Dutch patent 58,508 (Nov. 15, 1946).—*C. A.* 41, 4597.

Finely divided straw, peat, sawdust, lignite, dried sulfite waste liquor, and bagasse can be converted to ion exchangers by carbonizing with sulfuric acid that is prepared from spent gas-purifying masses because of the sulfur therein. The material is mixed with about an equal quantity of the spent gas-purifying material and treated in an acidproof vessel under pressure by hot oxidizing gases and steam to raise the temperature to 50° C.; the oxidation is catalyzed by the iron in the mass. The organic material is activated in about two days. If desired, a further treatment of 0.5 to some hours with strong sulfuric acid or sludge acid can be carried out at 100 to 200° C. The ferric sulfate is washed out and the product purified with acids or alkali to remove coloring matter.

463. Narain, Prakash and Bhatnagar, S. S. Bagasse resin and its plastics. *J. Sci. & Ind. Research (India)* 3, 396–9 (1945).—*C. A.* 40, 4543.

A resin has been prepared from bagasse. The raw material is washed with cold and then with hot water, and the residue is dried in the sun. It is chopped into small pieces, mixed with six parts of water, and hydrolyzed with 2% acid at 300 pounds pressure for three hours. The resulting mass is washed successively with cold and hot water and 2% calcium hydroxide solution, strained through cloth, and dried. The product is refluxed twice with 3.5 parts of alcohol for four hours each. The alcohol is distilled from the extract and the resinous residue is dried

at 100° C.; the yield, based on the bagasse, is 20%. The resin is black, lustrous, and soft; it melts at 165° C., has a specific gravity of 1.008 to 1.054, is 89% soluble in hot alcohol, and exhibits a faint fluorescence in ultraviolet light. The resin can be used as a binder for laminated jute fiber, plywood, or paper, for the manufacture of molding powder, for waterproofing, and for making varnishes and paints.

464. SCHORGER, ARLIE W., and FERGUSON, JOHN H. Molded lignocellulose product. U. S. patent 2,247,205 (June 24, 1941).—*C. A.* 35, 6351; Papermaking Abstr. 1, 210.

A method is proposed for the preparation of plastics from natural lignocellulosic materials, such as wood, corncobs, straw, bagasse, cornstalks, etc.; newsprint is also included. The cooking is carried out with an alkali (*see* U. S. patent 2,247,204 for list) at 180° C. for 30–60 minutes (although the conditions may vary somewhat for the different materials and also depending upon the type of product desired). The cook should be slightly acid at the end—pH of 5–6. The washed pulp is dried at 110° C., disintegrated in a mill, and screened; 65-mesh powder gives good results. This molding powder is plastic under hot-molding conditions and is well suited for molding operations. The material may be molded at 185–200° C. under a pressure of about 3,000 p. s. i.; 2–15 minutes are required. The material is preferably molded by giving it a preliminary cold press in the mold at 6,000–7,000 p. s. i., dropping the pressure, and then heating the mold. The resultant product is hard, has a resinous appearance, remains thermoplastic, and has many of the properties of products made by molding mixtures of a resin (such as Bakelite) and a filler (such as wood flour). The moisture absorption is usually less than 2% (2-inch disk, 1/32-inch thick, 18 hours at room temperature). The density is 1.40–1.45. The modulus of rupture is 7,000 p. s. i. when molded with a small amount of water and 8400 when molded dry. The product may be mixed with 2% of castor oil, pine oil, mineral oil, tung oil, or cumar-tung oil as a plasticizer. A small amount of zinc stearate may be added to the molding powder to secure better release from the mold. Phenols or organic amines may be incorporated before molding to increase the water resistance, plasticity, and strength of the molded product. Examples are given of the use of maple sawdust and corncobs.

465. SCHORGER, ARLIE W., and FERGUSON, JOHN H. Method for making molded lignocellulosic products. U. S. patent 2,283,820 (May 19, 1942).—*C. A.* 36, 6269.

This is a continuation in part of U. S. patent 2,247,205 (No. 464). The primary process consists in cooking a natural lignocellulose with water, alone or with added materials, within a limited range of temperatures and for a predetermined time to render water soluble a part of the lignocellulosic material and particularly to dissolve the hemicelluloses. The residual product, after extraction of the water solubles and subsequent drying, contains a large part of the original thermoplastic resinous lignin, as well as cellulosic fiber intrinsically unchanged. This product may be hot-molded under pressure, but without the addition of a binder, into a hard resinous product having a high strength and a high resistance to the absorption of water. In an example, one part of maple sawdust is cooked with 1 part of water and 5% of calcium carbonate (on the weight of the air-dry sawdust) in an autoclave at 185° C. for 1 hour, the pH at the end of the cook being 5.5–7. The cooked material is filtered and washed with water; the filter cake is dried at 110° C. to a water content less than 1%. This may be mixed, after disintegrating to a 100-mesh powder, with 2% of pine oil and 1% of zinc stearate, 2% of a mixture of equal parts of phenol and aniline, 2% of mineral oil and 0.5% of zinc stearate, or 2% of paraffin and molded, using in some cases prepressing. One part of straw and 2.5% of calcium hydroxide are cooked with 1 part of water at 185° C. for 1 hour, washed, dried at 110° C., ground to pass a 40-mesh screen, mixed with 5% of dextrose, and molded at 180° C. and 3000 p. s. i. for 7 minutes. In other examples, maple sawdust is mixed with one part of sulfate black liquor (containing 10% precipitable lignin) and about 5% of calcium carbonate, and digested for 1 hour at 180° C., or the sawdust is mixed with 4.5 parts by weight of aniline and 1.5 parts of formaldehyde and digested with black liquor (pH adjusted to 6.5–7) and calcium carbonate.

466. SHERRARD, EARL C., BEGLINGER, EDWARD, HOHF, JOHN P., and BATEMAN, ERNEST. Plastic composition. U. S. patent 2,130,783 (Sept. 20, 1938).—*C. A.* 32, 9496.

This invention relates to a process for treating sawdust, or bagasse, or other vegetable fibrous materials in such a manner as to change materially the composi-

tion of the lignocellulose complex, rendering it suitable for molding with or without a plasticizer, and to the product resulting from such a process. When a mixture of aniline and vegetable fibrous material is digested in the presence of water, a combined reaction takes place in such a manner that an aniline-lignocellulose complex is formed, together with free acetic and formic acids, and the originally basic mixture becomes strongly acid. The yield may be 85–95% of the original vegetable fibrous material. When washed free of water-soluble reaction products, ground to suitable fineness, and plasticized with furfural or other suitable lignin plasticizer, the product can be molded under heat and pressure, forming a very hard, dense, black, shiny product which has good strength and a high degree of water and electrical resistance. One hundred parts of wood waste, bagasse, etc., 100 parts of water, and 20 parts of aniline are heated at about 160 p.s.i. for 3 hours; to 100 parts of this aniline-lignocellulose complex are added 7 parts of furfural and the mixture is molded at 135–190° C. and a pressure of 1500–3500 p.s.i. In another example water is added to the complex to give a total moisture content of 10–20%, after which the material is molded as above.

467. Simmonds, Herbert R., Ellis, Carleton, and Bigelow, M. H. Handbook of plastics. New York, Van Nostrand Co., 1943. 1082 pp.

Manufacture of lignin plastics: pp. 515–7. "Lignin, present in wood to about 25%, is the binder of certain promising low-cost plastic materials. Wood chips, sawdust, cornstalks, straw, or cane bagasse may be used as the lignocellulosic source material. Usually this is treated to hydrolyze it to some extent by soaking it in dilute acid or treating it with hot water or steam, in the presence of acid. The softening point of the lignin is lowered with plasticizers such as aniline, but a full separation of the lignin from the cellulosic material is not necessary. The altered material is reduced to a finely divided state, either by grinding in a rod mill or (more commonly) by treatment in an exploding chamber or gun. The woody materials are exploded under steam pressure of 800 to 1,200 p. s. i. and at a temperature of about 260° C., separating the woody fibers from their lignin bond. The product is screened and then mixed with water to a pasty condition. Resins, lubricants, and fillers may be added, if necessary. Rubber, furfural, aniline, phenol-formaldehyde, benzyl cellulose, or other cellulose plastics are a few of the substances used. For the most part the woody material present serves as a good natural filler and the natural dark glossy finish of the plastic does away with the need for pigments. Petrolatum or paraffin in small quantity may also be added. The wet plastic mass from the mixer is loosely rolled into wet slabs or sheets which are then pressed into rods, tubes, or other molded forms, or may be dried and cut into mats which are later hot pressed to form finished, polished sheets. Alternatively, the material from the mixer may be loosely pressed and directly cut into sheets and transferred to the hot press. During the pressing, the lignin bond becomes set so that the finished product cannot again be disintegrated and rebonded. The process is similar to the themosetting of phenolic resins. Mats of the fibers are pressed by one company into panels which trim 4 by 12 feet and in thickness from 0.1 to 1 inch. Pressures up to 2,500 p. s. i. and temperatures up to 280° C. may be used. The product is cured normally at a temperature of 175° C. and a pressure of about 1,500 p. s. i. If desired, the finished sheet may be surfaced with phenolics or ureas in a variety of colors. In the manufacturing process during which the fibers are exploded, more complete use is made of the lignin bonding material than in the other or "paper type" method. The exploding treatment at once releases the lignin bond and at the same time activates the lignin. An automatic self-hydrolysis of the woody particles takes place, for the hot steam causes the formation of acetic and formic acids." A flow sheet is given.

468. Smyser, Frederic H. Cellulosic material. U. S. patent 2,056,810 (Oct. 6, 1936).—*C. A.* 30, 8445; *T. S.* 105, 377.

This is an improvement on U. S. patent 1,792,254 (Feb. 10, 1931). The addition of acid for the precipitation of the resinous substances on the fiber can be eliminated by controlling the original cooking of the cellulosic material. In the new process, 10 pounds of bagasse fiber, 1½ pounds of sodium hydroxide, and 100 pounds of water in a sealed digester are heated at 180–185° C. for 18–22 hours. The resulting fiber contains 15–18% resin. The liquor drained from this fiber is used to cook an additional 10 pounds of bagasse for 2–4 hours; the resulting product contains 25–30% resin. The two lots of fibers may be mixed for use. The pulp is advantageously molded in the presence of a heat-convertible synthetic resin, preferably a water-soluble phenolic resin prepared with an alkaline catalyst (e. g., sodium hydroxide or sodium carbonate); 15–20% of such resin is sufficient.

However, the digested material may be washed, dried, comminuted or powdered, and molded directly. If laminated material is desired, the washed fiber is treated in a beater, rod mill, or other suitable apparatus, and formed into sheets, which are then dried, laminated, and molded. Any thickness of sheet may be molded. It is essential that the board be cooled in the press before withdrawal therefrom.

469. Sorgato, Ippolito. Lignin from sorgo residue (bagasse) as a source of plastic material. *Ind. saccar. ital.* 32, 529–34 (1939); *Richerche sez. sper. zuccheri, Univ. studi padova, Ist. chem. ind.* 3, 101–12 (1939).—*C. A.* 34, 1481.

On acidifying the spent alkaline liquor obtained in the manufacture of cellulose from sorgo bagasse by the soda process, lignin is precipitated in a yield of 15% on the dry substance. The lignin contains 12% of methoxyl. The yield of lignin can be increased by employing a coagulant, but in that case the methoxyl content is slightly decreased. Various objects can be molded from the product.

470. Vogt, Clarence C. Artificial board and its manufacture. U. S. patent 1,718,011 (June 18, 1929).—*T. S.* 91, 92; *C. A.* 23, 4030.

Plant material other than wood (e. g., cornstalks, corncobs, straw, bagasse oat hulls, peanut shells, cat tails, salt hay, peat moss, and the like) are stated to contain a pentosan binder and other organic materials which may be converted into a resin-like condensation product by treatment with suitable agents (e. g., a phenol). The raw material is cooked in an autoclave for 0.5–1 hour at 140–180° C., with water in the autoclave or supplied by admitting steam under pressure into the autoclave. The resulting fibers are not washed but the solution is allowed to remain with them so that the fibers are kept in contact and are saturated with the solution containing the natural plant binder. This fibrous suspension is treated with a phenol and a suitable condensing agent (such as hydrochloric acid, ammonium chloride, or the like), which reacts with the natural binding agent to form an insoluble resinous condensation product when subjected to heat. The mixture is then formed into a board, which is baked to drive off the water and convert the natural binder into a water-insoluble binder. The heating may be at about 160° C. although a somewhat lower temperature for a longer period is preferable. It is probable that the lignin of these materials plays as important a part in the formation of the condensation products as do the pentosans.

471. Vogt, Clarence C., and Piefer, Ernest J. Artificial board and its manufacture. U. S. patent 1,718,012 (June 18, 1929).—*T. S.* 91, 92; *C. A.* 23, 4030.

This is a modification of Vogt's patent (U. S. patent 1,718,011, No. 470). The mixture of fibers, natural binder, phenolic body, and condensing agent contains also, according to the present invention, a pitch-like material (such as stearin pitch, petroleum pitch, wax talings, asphalt, coal tar, wood tar, or similar material) which improves the toughness of the board.

472. Willcox, O. W. Plastics from bagasse. *Sugar* 36, no. 9, 20–3, 28 (1941).—*B. C. P. A.* 1942B, II, 24, 77; *C. A.* 35, 8146.

The process of McElhinney and Aronovsky, as carried out in a pilot plant in Louisiana, is described and illustrated.

Chemical and Miscellaneous Studies

473. Airan, J. W. Phosphate from bagasse ash. *Current Sci.* (India) 17, 262 (1948).—*C. A.* 43, 3156.

Phosphate can be extracted with hot water from the ash obtained by burning bagasse with a firewood rich in potassium.

474. Amati, A. The possibility of using bagasse and exhausted quebracho in the preparation of decolorizing carbons. *Ind. saccar. ital.* 27, 549–51 (1934).—*C. A.* 29, 951.

Bagasse gives a poor product. The dry distillation of quebracho, followed by activation, heating to 600° with 20% magnesium oxide in the absence of air, results in a more efficient carbon than Carboraffin or Norit. The amount of activator is based on the weight of residue from the distillation; the product is washed until the runnings are neutral, then dried to 15% moisture.

475. Arnstein, Henry. The utilization of bagasse in the production of alcohol. I. II. *Planter and Sugar Mfr.* 81, 121–4, 143–4 (1928).—*C. A.* 22, 4861.

A review is given of the preparation of fermentable sugars and alcohol from cellulose material and similar experiments of Arnstein on bagasse fiber.

476. Babcock, Leon W. Explosives containing bagasse. U. S. patent 1,741,146 (December 31, 1930).—*C. A.* 24, 1220.

Ground bagasse which has been swollen without substantial disintegration by treatment with water, and the fibrous content of which is of normal porosity, is used with explosive ingredients such as ammonium nitrate and nitroglycerin, etc.

477. Browne, C. A., Jr. Hydrolytic products of sugar cane fiber. *J. Am. Chem. Soc.* 26, 1221–35 (1904).—*J. Soc. Chem. Ind.* 23, 1110.

The author has studied the products obtained by the hydrolysis of sugar cane fiber with dilute caustic soda solution. The purified fiber (200 grams), obtained by washing finely cut bagasse successively with water, 2% hydrochloric acid, and again with water, was digested for 8 hours with 3 liters of a 5% solution of caustic soda. The residual pulp was washed several times with small quantities of cold water and the washings added to the caustic soda solution. The pulp was then further purified by washing with hot water till free from alkali and finally with strong alcohol. From the caustic soda solution, the cane-gum was precipitated by alcohol, and purified by treatment with an alcoholic solution of hydrochloric acid, followed by washing with alcohol and then with ether. On hydrolysis with 4% hydrochloric acid, the gum yielded *l*-xylose and *l*-arabinose, the latter being isolated in the form of its benzylphenylhydrazone. Xylan and araban make up nearly 80% of the gum; the presence of galactan could not be detected. From the filtrate of the gum, lignin was precipitated by dilute sulfuric acid after expelling the alcohol. After purification, the lignin formed a brown-colored powder which, when treated with chlorine, yielded a product apparently identical with lignone chloride. The acid filtrate from the lignin yielded acetic acid when distilled in a current of steam. The cellulose obtained by digesting the cane fiber with caustic soda amounted, in the dry condition, to only 42% of the original fiber. This low yield, compared with the result obtained by Cross and Bevan's chlorination method, is due to the solvent action of the alkali, especially on the pith. The cellulose obtained by chlorination from the pith, fibrovascular bundles, and the rind was 49, 50 and 51%, respectively; that obtained by treatment with 1.25% sulfuric acid and 1.25% caustic soda was 42.9, 48.6, and 54.8%, respectively. These results have an important bearing upon the utilization of cane fiber for papermaking, because a chemical treatment necessary for the proper preparation of the rind would result in a large loss of pith. Drewsen [U. S. patent 731,290 (1903)] claims a process by which this loss is avoided, the pith being separated from the cane before digestion. The pith is not fibrous and has no felting properties, but paper prepared from it is stated to possess the quality and strength of parchment. The cellulose prepared from the cane fiber by digestion with caustic soda yielded dextrose on hydrolysis with sulfuric acid. The yields of the different products, calculated to the fiber free from protein, ash, fat, etc., were: cellulose 55, xylan 20, araban 4, lignin 15, and acetic acid 6%.

478. Cass, Oliver W. Farm wastes to be used in manufacture of nylon. *Chemurgic Digest* 6, no. 6, 97, 99–101 (1947).

Furfural can be manufactured from such agricultural byproducts as bagasse, oat hulls, corncobs, cottonseed hulls, flax shives, etc. The transformation of furfural into adiponitrile is shown in a chart and discussed briefly. Other compounds which can be prepared from furfural are listed.

479. Clacher, William. Use of bagasse carbon for decolorization in white sugar manufacture. *Intern. Sugar J.* 16, 64–6 (1914).—*C. A.* 8, 2635.

The coarser portion of bagasse is placed in a retort and calcined, after which it is passed over a ¼-inch mesh screen. The finer portion can be used to mix with the cane juice coming from the mill and the larger portion for the sirups. The carbon possesses good decolorizing power, but it is hard to revivify and its usefulness on a commercial scale is doubtful.

480. Coates, C. E. Preparation and evaluation of a decolorizing char from bagasse. *J. Ind. Eng. Chem.* 14, 295–8 (1922).—*C. A.* 16, 1675.

The distillation was carried out in two stages, the first being at 500–600° C., the second at 800–850° C. The product was then boiled two hours with 20%

sodium hydroxide, with addition of water to keep the concentration practically constant, and then with 1:1 hydrochloric acid, after which it was washed and dried at 200° C. This char had an apparent specific gravity of 0.136 and a decolorizing power of 260, compared with Norit 102, Darco 110. The char could be revivified by boiling with 5% sodium hydroxide and then with 5% hydrochloric acid.

481. Coxon, Frank. Acetic acid and its compounds. *Intern. Sugar J.* 20, 70–1 (1918).—*C. A.* 12, 1009.

Suggests the careful burning of bagasse as a source of supply.

482. Cross, W. E. By-products of the sugar industry. *Rev. ind. agr. Tucumán* 13, 81–128 (1922).—*C. A.* 17, 3426.

A general discussion of methods of utilizing the bagasse, filter cake, and molasses from cane sugar.

483. Cross, W. E. Three by-products of the sugar industry: tops, leaves and bagasse. *Rev. ind. agr. Tucumán* 32, 289–307 (1942); *Industrie y quim.* 5, 1–14 (1943).—*C. A.* 37, 4929.

The bagasse amounts to about 25% of the cane ground. It contains water 48, fiber 46.5, sugar 4, organic nonsugars 0.5, and ash 1%. It is used principally as factory fuel. Bagasse ash is used for fertilizer, as it contains 2–4% phosphoric anhydride; the potassium oxide (2–7%) is mostly in the form of silicates and unavailable. The outlook for the production of paper, alphacellulose, and Celotex from bagasse is not favorable in the Argentine, for various technical and economic reasons, which are discussed in detail. The manufacture of plastics, activated charcoal, and mixed feeds and the dry distillation of bagasse offer interesting possibilities.

484. Davis, B. L., and Phillips, Max. The hemicelluloses of sugar-cane fiber (bagasse). *J. Agr. Research* 63, 241–7 (1941).—*B. I. P. C.* 12, 136; *C. A.* 35, 8339.

The hemicelluloses were isolated from bagasse which previously had been freed of sugars and pectin. The product obtained was light gray and was practically free of nitrogenous substances and lignin. On hydrolysis with dilute sulfuric acid, it afforded D-glucuronic acid, L-arabinose, and D-xylose in the approximate molar ratio of 1:0.87:21.9.

485. Doss, K. S. G., and Jain, N. S. Activated carbon from bagasse. *J. Sci. & Ind. Research (India)* 3, 393–6 (1945).—*C. A.* 40, 4543.

The literature is reviewed. The method of Rao and Rao (see No. 527) furnishes a carbon as active as Carboraffin.

486. Dunning, J. W., and Lathrop, E. C. The saccharification of agricultural residues. *Ind. Eng. Chem.* 37, 24–9 (1945).

This study was concerned with the utilization of corncobs, sugarcane bagasse, flax shives, oat hulls, and cottonseed hulls; since the optimum conditions were found to be very similar for all the products, results are given only for corncobs. The first step consisted of a countercurrent digestion of the raw material with dilute sulfuric acid at a temperature just below its boiling point, which removed from 90 to 95% of the pentosan content. The residue was then dried and impregnated with concentrated sulfuric acid; the impregnated material was hydrolyzed by heating 45 minutes at 121° C. The yield from one ton (dry weight) of bagasse was: 93% pure crystalline xylose, 98 pounds; furfural, 155 pounds; 95% alcohol, 49 gallons; lignin, 327 pounds. The economics of the process is discussed.

487. Farnell, R. G. W. The pectic substances of sugarcane fiber. *Intern. Sugar J.* 25, 630–6 (1923).—*C. A.* 18, 597.

Coarsely chopped bagasse was washed for three days in running water and drained and rewashed until a test for residual sugars by alpha-naphthol proved negative. The pectinogen was extracted by digesting with either ammonium oxalate or oxalic acid (0.5% for two hours 80–90°), the extract clarified by filtration through filter pulp, and the pectin precipitated by the addition to the liquid of twice its volume of alcohol. The determination of pectinogen was made by the method devised by Misses Carre and Haynes, consisting of the conversion of the insoluble pectinogen into the soluble pectin, by hydrolyzing the plant tissue with 0.05 N hydrochloric acid and applying the calcium acetate method to the neutralized extract. The amounts of pectinogen found in cane fiber from various sources varied from 0.55% to 1.22%. These results show that the pectinogen

content of cane fiber is very small compared with that of turnips, onions, or peas. A preliminary study of the hemicellulose of cane fiber showed that, if it is present at all, it is not of the mannan-galactan type. The results are given of experiments on the extraction of cane fiber by various solutions and on the precipitation of pectin by various amounts of calcium hydroxide and sodium hydroxide. From the results obtained on the extraction of pectinogen from cane fiber, Farnell concludes that different clarifications used in sugar factories should not extract widely different amounts of this substance.

488. Feise, Fred W. Bagasse utilization by dry distillation. *Intern. Sugar J.* 33, 225–6 (1931).—*C. A.* 25, 6009.

Several attempts have been made in Brazil to convert dry bagasses into valuable products by distillation, but only one plant has passed the laboratory stage. The composition of the raw material is given as: fiber 67%, moisture 33%, maximum dimensions 12″ x 2″ x 0.5″, smallest fiber bundles 3″ x 0.5″ x 0.25″. Thermal conductivity with an experimental range of temperature of 50–180° was 0.0185. The yields of distillates in a laboratory scale test were; coke 34.5, condensable gases 8.5, noncondensable gases 31.6 and water 25.4%. Yields from the condensable gas fraction were: acetic and homologous acids 10.55, methyl alcohol 0.62, oily substances 14.22 (sp. gr. 0.94–1.034), soft pitch 63.25, water as obtained 10.35, gases and losses 1.01. Whereas one ton of bagasse produces on an average 2.3 tons of steam, from and at 100°, the pulverized coke produced by distillation evaporates between 7.0 and 7.2 tons of water from and at 100°. If the cost of producing the coke dust is taken into account, it seems hardly profitable.

489. Fernandez Garcia, R., and Colon, Isidoro A. Utilization of sugar-cane bagasse. *Bol. col. quim. Puerto Rico* 4, 12, 14–16, 18, 19 (1947).—*C. A.* 42, 126.

As oxidation products of glucose seemed to offer an opportunity for better utilization of the glucose from bagasse hydrolysis, some of the oxidation products were investigated. The preparation and properties of glucosaccharic acid are discussed.

490. Grogan, H. L. Composition of bagasse fractions obtained by sifting. *J. Soc. Chem. Ind.* 52, T63–4 (1933).—*C. A.* 27, 2839; *B. I. P. C.* 3, 179.

Bagasse was fractionated by sifting. The fraction remaining on the 5-mm. mesh sieve consisted almost entirely of rind tissue; that retained on the 4-mm. sieve was chiefly rind tissues, accompanied by aggregates of pith cells; with decreasing size of fraction, the proportion of rind tissues steadily diminishes, but even in the fraction retained by the 1-mm. mesh were found slivers of the rind. The fraction which passed through the 0.5 mm. mesh was composed only of pith tissues. Ten fractions were obtained. The differences in chemical composition between the fractions were very small. The data indicate that some direct relationship exists between the hydrochloric acid distillate and hygroscopic coefficient (coefficient of correlation, 0.62) and between the distillate and moisture (0.51). The hygroscopic coefficient is decided by: the surface area exposed, temperature, humidity of the atmosphere, content of matter in the colloidal state, and content of other substances with a high affinity for water. The probability of an inverse correlation between the lignin and cellulose contents is also indicated. Analytical values include moisture, ash, silica, benzene-alcohol (1:1) extract, pectin, hydrochloric acid distillate (pentosans and methylpentosans), lignin, cellulose (by difference), hygroscopic coefficient, maximum water-retaining capacity, specific gravity, and apparent density.

491. Hachihama, Yoshikazu. Bagasse. II. Water-soluble substances. *J. Soc. Chem. Ind. Japan* 36, 259B (1933).—*C. A.* 27, 4122.

An analysis of the alcohol-insoluble portion of the pectin hydrate gave some resinous matter, 29.6% of ash, 22.8% of uronic acid, 7% of pentoses, and 1.4% of methoxyl. The ash consisted mainly of calcium and magnesium oxides, with a little silica, alumina, and ferric oxide. Purification of the alchol-insoluble part by filtration of the aqueous solution through kieselguhr and reprecipitation with alcohol gave a product containing 34.4% of uronic acid. Galacturonic acid was isolated and identified. The pectin of bagasse resembles that of flax in its composition.

492. Hachihama, Yoshikazu. Bagasse. III. Hemicellulose. *J. Soc. Chem. Ind. Japan* 36, 634–634B (1933).—*C. A.* 28, 926.

Hemicellulose extracted from Formosan bagasse and freed from water-soluble substances, contains 12.8% of araban and 87.2% of xylan.

493. HACHIHAMA, YOSHIKAZU, and HAYASHI, GOICHI. Bagasse. I. Water-soluble substance. *J. Soc. Chem. Ind. Japan* 36, 258B (1933).—*C. A.* 33, 4122.

Bagasse, previously digested with water at 60° C. to remove sugars, was extracted 9 to 10 times with boiling water, yielding 2.8% of a pectin hydrate. The yield was increased to 14.1% on extraction at 120° and to 17.3% at 140°, but the pectin hydrate thus obtained was contaminated with decomposition products of the hemicelluloses. Extraction of the pectin hydrate with 70% alcohol gave 2.4 parts of a soluble hexopentosan and 1 part of an insoluble calcium-magnesium salt of pectic acid. Upon hydrolysis, the levorotatory hexopentosan gave 25% of resinous matter and 75% of a sugar mixture containing 56.4% L-arabinose, 9% D-galactose, and 34.6% D-fructose.

494. HACHIHAMA, YOSHIKAZU, and ONISHI, MEGUMU. Bagasse. X. Phenol derivatives isolated from the waste acid of the nitric acid pulping process. *J. Soc. Chem. Ind. Japan* 39, suppl. binding 362–3 (1936).—*C. A.* 31, 2423.

The various organic constituents of the waste acid were separated by a scheme which is outlined. In the solvent extraction of the waste liquor a yellow coloring matter was isolated, amounting to about 2% of dry material. This substance was found to contain mainly 3-nitro-4-hydroxybenzaldehyde, and small amounts of 3,5-dinitro-4-hydroxybenzaldehyde and 3-nitro-4-hydroxybenzoic acid.

495. HACHIHAMA, YOSHIKAZU, and SAEGUSA, HACHIRO. Studies on bagasse. V. General properties of bagasse lignin. *J. Soc. Chem. Ind. Japan* 37, *suppl. binding* 771.2 (1934).—*C. A.* 29, 1981.

Lignin was extracted from bagasse by digesting at 180° for two hours with a 25 mole-% solution of ethyl alcohol made slightly alkaline (pH 13) with sodium hydroxide. Three lignin fractions were separated, giving about 94% of crude product, which yielded 75% upon purification (m. p. 130–140°). No distinct differences existed between the fractions. The absence of pentosan and ethoxyl groups was established. Lignin extracted by dioxane digestion (small amount of hydrochloric acid) at 80–90° for five hours had a lighter color and melted at about 130°. It contained about 10% of combined pentosan and 15.2% of methoxyl or 16.9% methoxyl on a pentosan-free basis, in agreement with the values for ethyl alcohol extraction. Conclusion: Lignin extracted by aqueous solution of ethyl alcohol did not suffer any intense change at the high temperature.

496. HACHIHAMA, YOSHIKAZU, and SAEGUSA, HACHIRO. Bagasse. VI. Methyl and acetyl derivatives of bagasse lignin. *J. Soc. Chem. Ind. Japan* 38, 310B (1935).—*C. A.* 29, 6423.

Bagasse lignin was methylated with methyl sulfate and a 10% sodium hydroxide solution. Fully methylated lignin was obtained by two treatments, and it contained 31.77% methoxyl. The molecular weight, determined by freezing point depression in benzene and melting point lowering in camphor, averaged 1210. Analysis of methyllignin gave the empirical formula $C_{90}H_{39}O_5(OMe)_{12}$; hence that of the original bagasse must have been $C_{90}H_{39}O_5(OH)_6(OMe)_6$. Acetylation with acetic anhydride and pyridine gave an acetyl compound with 16.28% acetyl and 13.43% methoxyl; this suggests the empirical formula $C_{90}H_{39}O_5(AcO)_5(OMe)_6$ for acetyllignin.

497. HACHIHAMA, YOSHIKAZU, SAEGUSA, HACHIRO, and TAKEMURA, WASUKE. Bagasse. VII. Comparison of bagasse and wood lignin. *J. Soc. Chem. Ind. Japan* 38, 416–7B (1935).—*C. A.* 29, 8324.

Comparison of the ultraviolet absorption spectra and of the solubility of pentosan and lignin from hydrochloric acid and sodium hydroxide digested bagasse and Todomatsu softwood samples showed that bagasse lignin differs distinctly from softwood lignin and resembles hardwood lignin in physical and chemical aspects.

498. HACHIHAMA, YOSHIKAZU, and SHINRA, KOICHIRO. Bagasse. IV. Isolation of lignin by the action of alcohol. *J. Soc. Chem. Ind. Japan* 37, 584–5B (1934).—*C. A.* 29, 1276.

The most favorable conditions for extracting lignin from bagasse without affecting other constituents are: 20 cc. of aqueous ethyl alcohol (25 mole-% alcohol), made slightly alkaline (pH 13.0) with sodium hydroxide, for one gram of bagasse, the digestion mixture to be kept at 180° for two hours. About 95% lignin and 10% hemicellulose are dissolved. When the method was applied to

wood sawdust (Todomatsu) only 1/3 of the lignin and pentosan of the wood was dissolved.

499. HACHIHAMA, YOSHIKAZU, and TAKEMURA, WASUKE. Bagasse. XI. Picric acid isolated from the waste acid of nitric acid pulping process. *J. Soc. Chem. Ind. Japan* 40, 354–5B (1937).—*C. A.* 32, 1449.

The yield of nitrophenols was doubled by raising the concentration of nitric acid from 3–5 to 40–65%. With the more concentrated nitric acid, picric acid [$C_6H_2(NO_2)_3OH$] was obtained, whereas the less concentrated nitric acid gave lower nitrophenols. These products were also obtained from rice straw, wheat straw, and bamboo, but woody materials gave only small amounts of nitrophenols. A scheme is outlined for the course of picric acid formation from the phenol residue of lignin from annual plants. The formula for bagasse lignin is corrected to $C_{60}H_{40}O_5(OH)_6(OCH_3)_6$.

500. HAMAGUTI, EIZIRO, and KURAZAWA, HUMIO. Bagasse. I. Chemical properties of the material extracted by hot water, hydrochloric acid and ammonium oxalate solutions. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 10, 84–93 (1938).—*C. A.* 33, 5218.

The dry bagasse contained 2.4% ash, 3.9% crude protein, 24.3% lignin, 47.5% cellulose, and 30.1% pentosans. The hot-water extract contained 46.3% uronic acids. The residue was extracted with ammonium oxalate; the extract consisted of a uronic acid polymer only.

501. HARANG, THEOPHILE. Apparatus for the disintegration of bagasse and other vegetable matter. U. S. patent 278,545 (May 29, 1883).

502. HONDA, KOITIRO, and NAKAMURA, YUZURU. Chemical components of bagasse. *Rept. Govt. Sugar Expt. Sta., Tainan, Formosa* No. 6, 157–60 (1939).—*C. A.* 33, 7608.

The interior of the stalks of F. 108 is more lignified than POJ 2725 or 2883. The outer cellulose fibers are 1.5–3.5 mm. long and the inner fibers are 0.6–1.5 mm. long.

503. HONDA, KOITIRO, TATUNO, TUNEO, NAKAMURA, Y., GODA, T., MINA, Y., and YAMAHUZI, KAZUO. Composition of sugarcane. *Bull. Agr. Chem. Soc. Japan* 16, 49–54 (1940).—*C. A.* 34, 7132.

Bagasse contained 44.7% of fibrous cells 1.051–1.172 mm. long and 0.018 mm. wide. The stem of the cane after removal of sugar had the following composition: ash, 1.39–1.64%; cold-water extractives, 1.94–2.54%; hot-water extractives, 3.86–4.57%; dilute alkali extractives, 33.90–38.80%; alcohol-benzene extractives, 2.69–4.57% pentosans, 26.2–27.5%; lignin, 18.6–21.8%; nitrogen, 0.33–0.35%; cellulose, 47.7–50.3%; alpha-cellulose, 34.7–37.2%; beta-cellulose, 5.0–7.1%; gamma-cellulose, 5.8–8.2%; this is based on the dry weight of the bagasse. Pulp was prepared by digestion with sodium hydroxide.

504. HONDA, KOITIRO, WO, C., MIYAZI, N., and YAMAHUZI, K. Constituents of sugarcane. *Bull. Agr. Chem. Soc. Japan* 17, 71–5 (1941).—*C. A.* 36, 6287.

When an aqueous suspension of bagasse cellulose is treated with chlorine, hydrochloric acid is formed which decomposes the bagasse. Data are given for the amounts of ash, pentosan, lignin, and alpha-, beta-, and gamma-cellulose in bagasse after heating for 1 hour at 153° with 0.1, 0.05, 0.025, and 0.01% hydrochloric acid and after subsequent heating for 1 hour at 152° with 1 and 2% sodium hydroxide, and for the amounts of ash, pentosans, alpha-cellulose and for copper number and viscosity after bleaching a 5% suspension of the cellulose with bleaching powder at 40°.

505. ICHIKAWA, NOBUTOSHI, YAMASHITA, TAKEO, YO-HEIKEN, and KANO, MOTOHIRO. Production of alcohol from bagasse. I. Removal of pentosans by hydrochloric acid. *J. Soc. Chem. Ind. Japan* 44, 797–9 (1941).—*C. A.* 42, 2791.

In the removal of pentosans from bagasse with the minimum destruction of cellulose, which is later to be converted to sucrose for alcohol manufacture, the bagasse is best heated for 5 hours at 80° C. with 25 parts of 3.5*N* hydrochloric acid. About 93% of the pentosans can be removed and 68% of the cellulose preserved.

506. Langlykke, A. F., Van Lanen, J., and Fraser, D. D. Butyl alcohol from xylose saccharification liquors from corncobs. *Ind. Eng. Chem.* 40, 1716–19 (1948).—*C. A.* 42, 9067; *B. I. P. C.* 19, 74.

Xylose saccharification liquors obtained from corncobs in the first stage of a two-stage hydrolosis procedure may be fermented by a selected strain of butyl alcohol-forming bacteria if these liquors are supplemented by powdered iron or treated with activated charcoal prior to fermentation. Powdered iron serves to remove copper from hydrolyzates produced in copper-bearing equipment and, through its effect on oxidation-reduction potentials, also improves the environment for the bacteria. Solvents production and distribution obtained in the fermentation of the xylose liquors are comparable with those obtained with glucose and molasses media. The text indicates that the process can be applied to bagasse and other agricultural residues. See also U. S. patent 2,481,263 [No. 537].

507. Levey, Constance D. Molded material. U. S. patent 2,347,697 (May 2, 1944).

A composite article consists of a highly compacted mixture of powdered bagasse having less than 10% of moisture, and powdered gilsonite, there being present 1–2 parts of gilsonite to 4 parts of bagasse. At least one outer surface of the article consists of preformed thermoplastic sheeting bonded to the bagasse.

508. Locsin, Carlos L. Report on the uses of the byproducts of the cane-sugar factory. *Sugar News* 20, 467–70, 517–21 (1939); 21, 557–60 (1940).—*C. A.* 34, 2630.

Known and possible uses of bagasse are listed as fuel, bagasse board, cellulose, and dry-distillation products.

509. McFarland, Wm. E., Jr. Decolorizing carbon. U. S. patent 2,148,827 (Feb. 28, 1939).—*C. A.* 33, 4389.

An apparatus for manufacturing decolorizing carbon from vegetable matter such as cane bagasse or from lignite includes a primary kiln comprising a substantially vertical retort, an inlet at the upper end of the retort, an outlet at its lower end, conical baffles dividing the retort into substantially vertical coaxial chambers communicating with each other, a furnace enclosing the retort, and having substantially horizontal partitions dividing the furnace into sections surrounding the chamber. The apparatus also contains means for heating the furnace, means for controlling temperatures in the sections, means for removing the gases in each of the chambers resulting from the action of heat on the material therein, a second vertical retort, means for conducting material from the outlet to the second retort, means for heating the second retort, and means for conducting exhaust heat from the last-named heating means to the primary kiln.

510. Malowan, S. Sugar-cane (bagasse) as a raw material for nitro-cellulose. *Kunststoffe* 23, 153–4 (1933).—*C. A.* 27, 4392.

According to the Bureau of Chemistry and Soils of the U. S. Department of Agriculture, bagasse pulped by the Keebra or sodium sulfite process yields 38% of an easy-bleaching pulp containing 75–78% of alpha-cellulose and is suitable for the manufacture of cellulose nitrate.

511. Miyake, Suguru, Hamaguti, Eiziro, and Hirano, Shinzaburo. Utilization of bagasse. XI. Preparation of 2-furfuraldehyde from the pithy part of bagasse. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 14, 189–92 (1942).—*C. A.* 42, 3175.

The pithy part of raw bagasse (about 30%), heated three to four hours at 180° C. with 20 times the volume of 0.1% sulfuric acid, yields 13% 2-furfuraldehyde (on basis of bagasse) or 86% (on basis of the pith). Aluminum chloride was not an effective catalyst.

512. Miyake, Suguru, Hamaguti, Eiziro, and Kurasawa, Humiwo. Bagasse. II. Chemical properties of the hot-water and ammonium oxalate extracts of bagasse. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 11, 207–14 (1939).—*C. A.* 34, 6472.

A precipitate was obtained from the hot-water extract of bagasse by the addition of three volumes of alcohol. D-Galacturonic acid was isolated from the hydrolyzate of the precipitate. D-Galactose and L-arabinose also were found. The second precipitate obtained from the filtrate by further addition of alcohol consisted of arabinose only. No ketose could be found. After the hot-water extrac-

tion, the bagasse was extracted with a 0.5% ammonium oxalate solution. Copper sulfate was added to the extract. The precipitate obtained was treated with hydrochloric acid and 50% alcohol to remove copper. D-Galacturonic acid was isolated from the hydrolyzate of the precipitate.

513. MIYAKE, SUGURU, HAMAGUTI, EIZIRO, and KURASAWA, HUMIWO. Bagasse. III. Hemicellulose of bagasse. *J. Soc. Trop. Agr., Taihoku Imp. Univ.* 11, 215–26 (1939).—*C. A.* 34, 6472.

Bagasse was extracted with hot water and ammonium oxalate, and the residue was again extracted with 4% sodium hydroxide and 8% sodium hydroxide. A kind of hemicellulose consisting of 7–8% of arabinose and 93–92% of xylose, and another containing xylose, arabinose, and glucose were isolated.

514. NAKANO, M. Structure of vegetable fibers. I. Spiral structure of cotton, wood, manila, straw, bamboo and sugar-cane (bagasse) fibers. *Cellulose Ind.* (Tokyo) 5, 202–3 (1929).—*C. A.* 24, 2289.

The spiral structure (spiral cuticle) and the bead necklace effect on swelling in cuprammonium solution, which are shown by cotton and wood fibers, are obtained with bagasse and many other fibers. The spiral structure was successfully shown by swelling the fibers after weak xanthation.

515. NISIO, HUSAHARU, and AOKI, SIRO. Manufacture of furfural from bagasse. *Rept. Govt. Sugar Expt. Sta., Tainan, Formosa* No. 7, 231–7 (1940).—*C. A.* 35, 5741.

In laboratory experiments, 10 g. of bagasse pith (10% moisture) were hydrolyzed for 3 hours at 3 atmospheres pressure with 0.5–1% of sulfuric acid in the presence of 0.5–5 g. of aluminum chloride. Maximum yield amounted to about half the pentosan content (24.5%) of the pith. Without aluminum chloride, the yield is only ½ or ⅓ as much. When phosphoric acid is used instead of sulfuric acid, the residue is not carbonized.

516. NORRIS, R. S. Heat of combustion of bagasse from Hawaiian cane. *Agr. and Chem. Series, Agr. Expt. Sta., Hawaiian Sugar Planters' Assoc., Bull.* 40 (1912).—*C. A.* 6, 3204.

The heat of combustion of fiber from 44 samples of different varieties of sugar cane, determined with an Atwater-Berthelot bomb calorimeter, ranged from 4494 to 4636 calories. The corresponding values for bagasse were 100 calories lower. The elementary composition of dry bagasse containing 13.8% sugar was carbon 48.1%, hydrogen 5.6%. A complete bibliography of bagasse as a fuel is given.

517. OSHIMA, YASUYOSHI, HARA, TAKESHI, and KOBAYASHI, KATSUMI. Preparation of furfural from bagasse. I. Extraction of pentosans by chloride solution, especially brine, and the nature of the residue. *J. Agr. Chem. Soc. Japan* 19, 897–908 (1943).—*C. A.* 43, 628.

Boiling bagasse (crude cellulose 47–52%, pentosans 26–28%, and lignin 18–22%) by the Adams-Voorhees method [Organic Syntheses 4, 49–52 (1921), furfural is prepared from corncobs, 10% sulfuric acid, and sodium chloride] but using other chlorides and less sulfuric acid yielded far more furfural [0.1% with sodium chloride, 1.0% with zinc chloride, 19.7% with calcium chloride, 27.6% with magnesium chloride (the maximum of 93% is obtained with magnesium chloride and a larger quantity of sulfuric acid), and 36.9% with aluminum chloride]. The use of a brine (magnesium sulfate 5.6–7.5%, magnesium chloride 12.4–20.4%, potassium chloride 2.5–3.7%, sodium chloride 1.4–13.1%, sodium bromide 0.3–0.5% and calcium carbonate trace) instead of chlorides gave about the same yield as that with magnesium chloride; hydrochloric acid could replace the sulfuric acid. Under suitable conditions, using a smaller quantity of hydrochloric acid, pentosan (before being decomposed to furfural) was obtained in a high yield, which was increased with larger quantities of hydrochloric acid and brine, a higher boiling point of the brine, and longer boiling. With such an increase, the residual cellulose decreased; however, 80 and 75% of the α-cellulose originally present in the bagasse remained in the residue when 80 and 94% of the pentosans were present in the brine. Repeated boiling of fresh bagasse with the same brine or of the same bagasse with fresh brine increased the yield of pentosans to at least 90%.

518. Oshima, Yasuyoshi, Hara, Takeshi, and Kobayashi, Katsumi. The preparation of furfural from bagasse. II. Preparation of furfural from the brine extract and the nature of the pulp prepared from the residue. *J. Agr. Chem. Soc. Japan* 20, 43–51 (1944).—*C. A.* 43, 629.

Pentosans in the brine extract of bagasse (see No. 517) can be transformed into furfural by heating under pressure; the furfural disappeared unless separated immediately. With special precautions, about 90% of the brine extract could be obtained as furfural in a concentration of 3% or higher by heating under atmospheric pressure. Acetic acid is also formed. By heating bagasse directly with brine and hydrochloric acid, a similar result was obtained with a slight loss of pentosans (equivalent to 5% of the pentosans). Pulp made from the fibrous residue after extraction of 35–40% of the pentosans contained relatively less pentosans and relatively more alpha-cellulose.

519. Othmer, Donald F., and Fernstrom, George A. Destructive distillation of bagasse. *Ind. Eng. Chem.* 35, 312–7 (1943).—*B. I. P. C.* 13, 302; *C. A.* 37, 1848.

Bagasse consists of 25–40% fiber cellulose, 0.1–0.15% gums, etc., 6–10% sugar and 40.55% water. Its ultimate analysis on the dry basis is: carbon 43–47%, hydrogen 5.4–6.6%, oxygen 45–49%, ash 1.5–3%. The heating value of dry bagasse is 8300 B. t. u. per pound. The net heating values are 2200–3350 B. t. u. per pound; 4–6 pounds of bagasse are equivalent to a pound of coal. The tremendous amounts of bagasse available at single points and the fact that charcoal is an important domestic fuel in most tropical countries made desirable the investigation of the carbonization of this waste plant fiber. Details are given of the retort used and of the plan of distillation. The following data for bagasse (with data for other materials shown in the table) were obtained in an experiment designed to determine the effect of applying heat at a moderate rate for a short time (2 hours); the final temperature was only 618° F. and, therefore, a high yield of charcoal was obtained; the highest yields of acetic acid and tar were also obtained in this run.

	Wood	Wheat Straw	Corncobs	Bagasse
Raw material:				
Moist, lb	4000	3000	3360	3210
Dry, lb	3000		3000	3000
Charcoal, lb	1000	1000	900	1570
Gas, cu. ft	7000	[1] 1050	[1] 600	1080
Total distillate, gal	250	104	144	93.5
Tar discharged, gal	26	11	14.7	9.74
Methanol (85%), gal	10		4	1.82
Acetic acid (100%)	120	26	78	77

[1] Pounds.

The charcoal is bulky and comes as a fine, pulverent material. It is easily made into briquets with a small amount of starch or molasses. The texture of the charcoal indicates that it might be suitable for activated carbon. It seems that bagasse might be profitably carbonized in some locations because of the products, particularly charcoal, and the fact that the material is available at a single point in large quantities. The physical nature of bagasse indicates that the advantages of continuous carbonization by the modification of a continuous retort used for wood waste should be realized.

520. Owen, Wm. L. Blackstrap molasses as raw material for biochemical industries. XIV. Potential sources of raw materials in cane tops and other wastes. *Facts About Sugar* 33, 43–6 (1938).—*C. A.* 32, 8688.

Attention is called to the possibility of utilizing cane tops for the manufacture of alcohol or rum, and bagasse and other cellulosic wastes for the manufacture of fuel gas by anaerobic fermentation, or of alcohol after hydrolysis.

521. Owen, Wm. L. Alcohol production by fermentation. U. S. patent 1,748,791 (Feb. 25, 1930).—*C. A.* 24, 1931.

A sterilized mixture of a bagasse and molasses wort is subjected to the fermenting action of seed yeast until the yeast cells have become distributed upon the bagasse fibers and the wort has been reduced to one-half its original density, and

this fermenting mixture is then transferred to a body of molasses wort in which it is desired to produce alcoholic fermentation.

522. Owen, Wm. L., and Bennett, Norman. Fermentation of bagasse in relation to the yields of industrial alcohol. *Intern. Sugar J.* 28, 463–70 (1926).—*C. A.* 20, 3831.

The rapidly increasing utilization of cane bagasse for the manufacture of fiber board, "Celotex," and the necessity of storing the baled bagasse as a reserve supply during the year, have introduced a problem of preserving this material from deterioration in storage. Since the residual sugars in the bagasse tend to hasten its deterioration, their removal by fermentation into alcohol might prove economically feasible. The sugars in baled bagasse did not ferment very readily, and the addition of the bagasse to a molasses wort tended to depress the yield of alcohol and to lower the efficiency of the fermentation of the sugars in the molasses. However, a bagasse which was first extracted with water and then treated with a sugar solution comparable in composition with a cane juice, did not depress the yield of alcohol from a molasses wort, and the over-all efficiency of the mixture of bagasse and molasses solution was practically as good as on the molasses alone. This indicates that, with fresh bagasse, satisfactory yields of alcohol could be obtained.

523. Owen, Wm. L., and Denson, Wm. P. Sugar-cane bagasse as a source of alcohol. *Planter Sugar Mfr.* 80, 61-4, 83-5, 102-5 (1928).—*C. A.* 22, 4711.

Preliminary experiments with baled bagasse demonstrated (1) that the fermentable sugars in bagasse can be efficiently converted into alcohol by fermentation. (2) That the rate of fermentation of solutions was accelerated by the addition of bagasse even where the alcohol yields from the sugars present were not increased. More elaborate experiments on a laboratory scale indicate that higher yields of alcohol from fermenting molasses may be expected and that by addition of bagasse to worts of high density (33° Brix), a 25% greater alcohol yield is obtainable in ⅓ shorter time. In order to preserve the exhausted bagasse chips for the manufacture of fiber board, these may be subjected to acetic fermentation by substitution for beech shavings in vinegar generators. A line of procedure for the utilization of bagasse in the fermentation industry is suggested and its value in the distillery calculated, as well as the possibility of the absorption of Louisiana bagasse by local distilleries and the value of spent bagasse for the manufacture of fiber board.

524. Payne, John H., Fukunaga, Edward, and Kojima, Ruth. Properties of bagasse lignin extracted by the dilute nitric acid method. *J. Am. Chem. Soc.* 59, 1210–3 (1937).—*C. A.* 31, 6001.

Bagasse, which had been extracted with 2:1 benzene-ethanol and then with water, was heated in lots of 100 grams with 1000 cc. of 1.42% nitric acid for one hour at 98–100° C. After washing with water and drying, the material was again extracted with benzene-ethanol to remove picric acid. The nitrated bagasse was heated just to boiling with 1% sodium hydroxide, the cellulose filtered off, and the filtrate acidified with dilute hydrochloric acid; the yield of crude lignin was 12 grams. The lignin was purified by repeated solution in dioxane and precipitation into ethyl ether; five such purifications give a pure product with 55.77% carbon, 5.27% hydrogen, 1.77% nitrogen, 4.19% hydroxyl and 14.7% methoxyl. The nitrogen content corresponds to an empirical molecular weight of 791; this minimum unit contains approximately 2 hydroxyl groups and 4 methoxyl groups. Molecular weight determinations by the freezing point method in dioxane gave an average value of 1650. The absence of carboxyl groups is indicated by the electrometric titration curves. Methylation and acetylation data confirm the unreliability of these methods for determining the percentage of hydroxyl in the lignin molecule.

525. Ramiro, Mariano P. Industrial uses of sugar-cane bagasse. *Sugar News* 22, 183–6 (1941).—*C. A.* 35, 6478.

Bagasse can serve as a raw material in the manufacture of pulp, paper, rayon, lacquer, plastics, and fiber boards.

526. Rao, A. Nagaraja, and Rao, S. N. Gundu. Activated carbon from bagasse. *Current Sci.* 6, 616–7 (1938).

A highly activated form of carbon was obtained from sugarcane bagasse as follows. Treat the bagasse with a sufficiently strong solution of zinc chloride,

with the use of heat, to obtain a highly gelatinous mass, heat to near dryness at low temperatures, and heat to a definite temperature in an ignition furnace. When the evolution of steam and other gases has stopped completely, and after maintaining the furnace at the optimum value for 30–60 minutes, slowly cool the mass, crush, treat with hydrochloric acid solution, filter, and wash with water until the wash water is no longer acid. After drying, the carbon is ready for use. The zinc chloride can be largely recovered and reused.

527. Rao, A. Nagaraja, and Rao, S. N. Gundu. Activated carbons from bagasse and other Indian raw materials. *Ind. and News Ed. J. Indian Chem. Soc.* 2, 161–70 (1939).—*C. A.* 34, 4239.

Carbon made from bagasse, paddy husk, ground-nut husk, coconut shell and coir and molasses, when treated with sodium hydroxide or hydrochloric acid solutions and activated with steam at 800–850°, showed little activity for decolorizing caramel solutions. Impregnation and digestion of the raw materials with activating agents, like sulfuric acid, zinc chloride, and aluminum chloride, followed by suitable treatment after carbonization, yielded carbon possessing marked decolorizing properties toward caramel solutions and other coloring and colloidal matter that may be present in sugar liquors.

528. Rocha de Almeida, Jaime. Composition of sugar-cane bagasse and its ash. *Brasil açucareiro* 31, 632–9 (1948).—*C. A.* 42, 8003.

Average proximate analyses (10 samples) of Brazilian-grown cane show: fiber 42.2%, reducing sugars 0.44%, ash 1.3%, moisture 49.5%, undetermined 1.8%. Constituents on an airdry basis: moisture 9.5%, ash 2.1%, soluble in cold water 1.1%, solubie in water (100° C.) 3.6%, soluble in 1% sodium hydroxide (100° C.) 5.3% (corrected for solubility in hot water 1.5%), wax, fat, and resins 2.93%, acetic acid (hydrolysis with 2.5% sulfuric acid) 4.1%, methoxyl groups 1.5%, pentosans 24.2%, methyl pentosans 0.9%, cellulose 51.3%, lignin 19.8%, soluble in 10% potassium hydroxide (100° C.) 44.6%, copper number 2.1, proteins 1.2%, α-cellulose 40.2%. The composition of the ash (2 samples): silica 70.46, 72.61%; calcium oxide 3.98, 4.03%; magnesium oxide 4.27, 2.32%; potassium oxide 8.17, 9.36%; sodium oxide 2.04, 1.71%; phosphorus pentoxide 2.61, 2.24%; ferric oxide 1.38, 1.61%; alumina 1.91, 0.93%; chlorine 0.41, 1.71%; sulfur trioxide 4.39, 6.42%; alkalinity of ash 169, 151.4; soluble ash 2.63, 3.71%.

529. Scott, W. By-products of the sugar industry. *Planter Sugar Mfr.* 79, 368–9 (1927).—*C. A.* 22, 1869.

A review is presented of the utilization of cane trash as fuel and as a field mulch, and of bagasse for fuel, fiber board, paper pulp, and as a source of cellulose. Molasses may be used directly as cattle food, fuel, or fertilizer, or may be converted into rum, industrial alcohol, and yeast. Filter press cake is employed chiefly as fertilizer. Ashes from bagasse furnaces contain phosphorus and potassium, and may be mixed for fertilizer with the press cake or they may be used as a track ballast or for pathways.

530. Sherrard, E. C., and Blanco, G. W. The acid hydrolysis of sugarcane fiber and cottonseed hulls. *J. Ind. Eng. Chem.* 12, 1160–2 (1920).—*C. A.* 15, 519.

Bagasse was digested with 1.8–2.5% sulfuric acid for 17–50 minutes at a pressure of 100–125 pounds. After blowing to atmospheric pressure, the material was centrifuged and the remaining sugar extracted in leaching towers. The liquors were mixed, the acid neutralized with calcium carbonate, and the solution evaporated to a sugar content of 5–7%. The average of nine fermentations showed only 24.2% of fermentable sugar, as determined from the quantity of sugar removed, and of this only 50–60% were obtained as alcohol. It is probable that the presence of a pentose interfered with the production of fermentable hexoses. Bagasse was extracted with 2% ammonium hydroxide at room temperature for 24 hours and then digested with 7% sulfuric acid for 2 hours. The ammonia extraction removed 15% of the original dry material and the acid treatment removed 35.8% of the residue. The total reducing substances in the acid liquor corresponded to 21.2% of the original dry fiber. From this liquor were isolated 12.1% of xylose (on basis of original dry fiber), or 57% of the total sugar determined by Fehling solution. This probably does not represent the maximum yield. Thus, bagasse is a very promising source of xylose and furfural.

531. Stevens, George de and Nord, F. F. Lignin and lignification. VIII. Isolation and characterization of bagasse native lignin. *J. Am. Chem. Soc.* 73, 4622–5 (1951).

Bagasse native lignin has been isolated and characterized with respect to chemical composition, solubilities in various solvents, color tests, the acetate and phenylhydrazone derivatives, and ultraviolet and infrared absorption spectra. Lignin liberated by the action of the cellulolytic mold, *Poria vaillantii*, was also isolated and found to be identical with the native lignin in all respects. Enzymatic decay increased and yield of native lignin eight times. Ultraviolet spectroscopic studies reveal that bagasse native lignin probably contains a carbonyl group or ethylenic double bond conjugated with a dioxyphenyl ring. The oxidation of the native lignin yielded vanillin and syringaldehyde in a ratio of 1 to 0.75. Thus, bagasse native lignin is a guaiacyl-syringyl lignin.

532. Subramaniam, K. S., and Rao, B. S. Utilization of bagasse. *Proc. Soc. Biol. Chem. India* 1, 5 (1936).—*C. A.* 32, 3651.

On digestion, bagasse yields 10–12% of furfuraldehyde. The dried residual material may be utilized as fuel or for cardboard manufacture.

533. Tatsuno, Tsuneo. Bagasse as a water-absorbing material. *Rept. Taiwan Sugar Expt. Sta.* (*Formosa*) No. 1, 111–16 (1947).—*C. A.* 42, 1031.

Dried and powdered bagasse can absorb 20% of its weight of water from an atmosphere saturated at 25–30° C. and can retain three to five times its weight of liquid water. A mixture of 50 grams of the airdry powder and 200 ml. of a 20% brine of magnesium chloride, when dried, absorbed 155% of its weight of water from air of 100% relative humidity in 18 days. Pure calcium or magnesium chloride will not absorb as much water under similar conditions.

534. Tatsuno, Tsuneo, and Goda, Hidetosi. Morphological and chemical researches on bagasse of new varieties of Saccharum officinarum. I. *Rept. Govt. Sugar Expt. Sta., Tianan, Formosa*, No. 7, 203–18 (1940).—*C. A.* 35, 5741.

In quantity ratio of fiber and nonfiber cells to hard cells, new F. varieties at 18 months occupy a position between aspen and beech. Length of fiber in the fibro-vascular bundles is around 1.05–1.17 mm.; the average width is 0.018 mm. The sugar-free bagasse had approximately 50% crude cellulose, 27% pentosans, and 21% lignin. No relation was found between the sugars and the crude cellulose of the canes, but there is a close relation between fiber content, crude cellulose, and the hardness of the cane stalk.

535. Taylor, Wm. A. Plant products as chemical raw materials. *Chem. Age* (N. Y.) 31, 549–51 (1923).—*C. A.* 18, 871.

Taylor summarizes the products available as raw materials from straw, corn, sugar-cane bagasse and tops, and long-fiber by-products. Possibilities are mentioned of producing industrial alcohol from potatoes or sugar beets; of a more varied utilization of soy beans; of using tobacco for nicotine production; of replenishing the American tannin supply, necessary as a result of the ravages of the chestnut blights; as well as applications of various other materials for chemical raw materials.

536. Tejada M., Carmen J. Furfural preparation from the bagasse of sugar cane. *Rev. facultad farm. y bioquim., Univ. nacl. mayor San Marcos* (Lima, Peru) 12, 108–28 (1950).—*C. A.* 45, 2696.

The yield of furfural obtained by distillation of bagasse under reduced pressure was 3.5%.

537. Tsuchiya, Henry M., Van Lanen, James M., and Langlykke, Asger F. Fermentation process. Butanol and acetone from media containing pentose sugars—e. g., corncob, oat hull, and bagasse hydrolyzates. U. S. patent 2,481,263 (Sept. 6, 1949).

This patent covers the process described by Langlykke, *et al.* [No. 506].

538. Valet, Earnest C. H., and Funk, O. Artificial silk from the cellulose of sugar-cane bagasse. British patent 287,461 (March 19, 1927); French patent 651,491 (March 19, 1928).—*C. A.* 23, 514, 3344.

Cellulose obtained from bagasse may be used for the preparation of nitrates, acetates or xanthates or solutions in alkalies or cuprammonium solution for the manufacture of artificial silk.

539. WIGGINS, L. F. The sugar cane as a source of raw materials for chemical industry. *Chemistry and Industry* 1949, 555–60.—*B. I. P. C.* 20, 5.

The importance of research on the utilization of products of the sugar industry is pointed out. The possibilities of cane wax, bagasse, molasses, and sucrose as chemical raw materials are reviewed.

540. WILLIAMS, J. F. Experiments with bagasse carbon. *Trop. Agr.* (Trinidad) 11, 107–10 (1934).—*C. A.* 28, 7578.

Decolorizing carbon can be prepared from bagasse by low-temperature destructive distillation and then by twice heating the ground char loosely packed in a closed vessel to red heat for six hours. The char is finally ground to pass a 100-mesh sieve. Its decolorizing power is almost equal to that of Suchar but it has a high content of basic ash.

541. WILLIAMS, J. N. S. Economic possibilities of fine fractions of bagasse. *Repts. Assoc. Hawaiian Sugar Tech.* 13, 162A–D (1934).—*C. A.* 30, 4031.

Bagasse from a number of the principal varieties of sugar cane grown in Hawaii was subjected to a comprehensive chemical analysis. In the following: A—percentage of crude cellulose, B—alpha-cellulose (percentage in crude cellulose), C—beta-cellulose (percentage in crude celluiose, D—gamma-cellulose (percentage in crude cellulose), E—alpha-cellulose (percentage in bagasse), F—ash in bagasse, G—elevation in feet, H—age in months at harvest,

	H 109	Yel. Cal.	D 1135	D 1135	D 1135	POJ 2878
A	52.60	51.28	50.12	49.81	52.26	54.81
B	66.10	67.15	70.08	54.37	57.03	68.83
C	20.72	20.90	18.13	39.41	36.20	21.06
D	11.88	11.95	9.19	4.09	6.54	5.86
E	34.77	34.44	35.12	27.08	29.80	37.64
F	1.17	2.17	2.00	0.96	0.98	0.80
G	458	525	400	1800	1000	1200
H	22	22	22	18	22	23

Appendix O

SUPPLEMENTAL BIBLIOGRAPHY ON BAGASSE

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